University of Alberta

Sustainable Development of the Aggregate Resources of Alberta

by

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A thesis submitted to the Faculty of Graduate Studies and Research in partial fulfillment of the

requirements for the degree of Master of Science

Department of Atmospheric and Earth Sciences

Edmonton, Alberta
Fall 2004

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Your file Votre référence
ISBN: 0-612-95831-0
Our file Notre référence
ISBN: 0-612-95831-0

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DEDICATION

To my father, **Paul**, who initiated and heightened my interest and awareness of the physical properties of Earth;
my mother, **Alice**, who guided me spiritually; **Rose Mary**, my former partner, co-creator and sustainer of the Peel genes, my daughters **Lorinda**, **Sherilyn** and son **Ryan**, for their support and cooperation; my uncles, **Ed** and **George Bleiler**, who initiated my career path towards the mining sector; **Amanda Brahn**, **Holly (Harmoniah) Leblanc** and **Terri Rambold**, who dared me to dream.

PREFACE

Land and resource management are becoming more complex as expanding human populations demand more resource/land development on one hand, while imposing restrictive conservation measures on the other. As a result, resource and land managers are becoming more polarized as the conservation and development demands increase. Acting as a resource manager for the Alberta provincial government, I am finding my mandate increasingly more difficult when attempting to convey to my peers and management, the value of resources that have been largely been taken for granted by both the public and geoscientists. When Doug Radke, Deputy Minister of Environment (2000), enticed his department's staff to take advantage of an education leave opportunity, offered by government, I used this time to research how aggregate resources contribute to Alberta's prosperity and where improvements to the present governance towards the aggregate resource sector could be implemented to maximize the benefits of these resources.

I am happy to report my research concludes most jurisdictions, globally, are starting to recognize the importance of the aggregate resources. Further, with the movement towards sustainable development, there is a promise of obtaining balanced resource/land management decisions, which means giving due consideration to the aggregate resources in all future conservation-development decisions.

ABSTRACT

The United Nations' concept of sustainable development promises a healthy and peaceful Earth for future generations. The concept considers that minerals are essential for modern living, with mining as an important activity that can enhance the path to sustainable development. Many mining-specific initiatives, are building on the concept of sustainable development. However, because aggregate resource (sand and gravel) extraction is rarely recognized as part of the mining sector, these highest consumed minerals are not being identified within the context of these initiatives. To qualify the aggregate resource sector, in context of sustainable development, the management of these resources is examined in light of geology, distribution, governance, and industry practices, within Alberta. The significance that aggregate resources have for economic, environmental, and community considerations are quantified through "Seven Questions to Sustainability" (Mining, Minerals and Sustainable Development) towards a municipal planning process. Overall, the research concludes that improved governance towards the aggregate resource sector can contribute significantly to sustainable development in Alberta.

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List of abbreviations

ACR	Alberta Chamber of Resources
AGS	Alberta Geological Survey
ARHCA	Alberta Roadbuilders and Heavy Construction Association
ARIP	Aggregate Resource Inventory Program
ASGA	Alberta Sand and Gravel Association
ASP	Area Structure Plan
CAMIRO	Canadian Mining Industry Research Organization
CDN	Canadian
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
CEO	Corporate Executive Officer
CGC	Canadian Geoscience Council
ENR	Energy and Natural Resources
EPEA	Environmental Protection and Enhancement Act
GAC	Geological Association of Canada
GDGMSD	The Global Dialogue of Governments on Mining/metals and Sustainable Development
GIS	Geographical Information System
GMI	Global Mining Initiative
ICMM	International Council on Mining and Metals
IIED	International Institute for Environment and Development
IISD	International Institute for Sustainable Development
IRM	Integrated Resource Management
MAC	Mining Association of Canada
MMSD	Mining, Minerals and Sustainable Development
NESS	Northern East Slopes Strategy
NIMBY	not in my back yard
NRCan	Natural Resources Canada
NSERC	Natural Sciences and Engineering Research Council of Canada
NWT	Northwest Territories
PDAC	Prospectors and Developers Association of Canada
SAGDAT	Sand and Gravel Direct Action Team
SEG	Society of Economic Geologists
SMARA	Surface Mining and Reclamation Act
SML	Surface Material Lease
SRD	Sustainable Resource Development
SUM21	Sustainable Mining in the 21st Century
UNDP	United Nations Development Programme
UNESC	United Nations Economic and Social Commission
WCED	World Commission on Environment and Development
WBCSD	World Business Council for Sustainable Development
Westac	Western Transportation Advisory Council
WMI	Whitehorse Mining Initiative
WMMF	World Mineral Ministries Forum

ACKNOWLEDGEMENTS

I would like to take this opportunity to pay special tribute to **Dr. Jeremy Richards**, P.Geol., of the Faculty of Earth and Atmospheric Sciences, University of Alberta for his direction towards pursuing a Master's degree. His patient, persistent, and professional supervision was well above and beyond the call of duty.

The project has been richly enhanced through the assistance of people associated with the following organizations:

Alberta Sand and Gravel Association

Bruce Whale, Jim Sawchuk, P.Eng., **Darrell Quist**, P.Eng., **Gordon Pasini, Ron Dales, Dave Clark**, and **Doug Baumann**, ASGA Executive Directors (2001-3) for approving the concept and providing the financial support of the project, in particular **Vic Walls**, who acted as project manager. All those members who dedicated their valuable time to give their input to the industry survey: **Don Assinger** (Assinger Concrete Ltd.-Stony Plain), **Rolly Boissonnaulp** (Aggregate Management Inc.-Ft. McMurray), **Dan Cardinal**, P.Geol., (Mistassini Aggregates Inc.-Ft. McMurray), **Dave Clark** (Inland Aggregates Limited-Calgary), **Hans Heltke**, P.Geol. (Suncor Energy-Ft.McMurray), **Ron Klippert** (Klippert Sand & Gravel-Calgary), **Dom Kriangkum**, P.Eng. (DK Engineering Services Ltd.-Edmonton), **Fred Lynch** (Consultant-Edmonton), **Shaun Parsons** (General Gravel Sales Ltd.-Edmonton), **Gordon Pasini** (Carmacks Sand and Gravel Ltd.-Edmonton), **Terry Mix** (Mixcor Aggregates-Leduc), **Merv Rogan**, P.Geol., (Target Products Ltd-Morinville), **John Moquin** (Inland-Edmonton), **Ed Nash** (Nash Enterprises Ltd.-Slave Lake), **Vernon Torstensen** (Consultant-Edmonton), **Don Scheurman** (Fish Creek Excavating Ltd.-Calgary), **Eric Stanier** (Border Paving Ltd-Stony Plain), **Derald Starchuk**, P.Eng., (Millennium EMS Solutions Ltd.-Edmonton), **Henry Wiebe** (Inland Concrete Ltd.-Edmonton), and **John Wilson** (H.Wilson Industries Ltd.-Ft. McMurray).

Alberta Chamber of Resources

Don Currie, P.Geol., **Brad Anderson**, P.Geol., **Dr. Stan Boutin** and **Peter Koning**

Alberta Energy

Brian Hudson, P.Geol., **Susan Carlisle**.

Alberta Environment

Doug Radke for providing the education leave opportunity, **Chris Powter**, and **Shauna Kryba**.

Alberta Geological Survey

Lawrence Andriashek, P.Geol., **Heather Budney**, Geol.I.T. **Mark Fenton**, P.Geol., **Dan McGee**, and **Reg Olson**, P.Geol., **John Pawlowicz** and especially **Dixon Edwards**, P.Geol., Alberta's leading authority on aggregate resources, who provided expert guidance.

Alberta Municipal Affairs

Bill Symonds

Alberta Transportation

Bruce Blue, Chuck McMillan, P.Eng., **Tim Hawnt**, P.Eng., **Jay Ramotar**, P.Eng., and **Eliza Leung**

ESRI

Dean Pickering and **Neil Cory** for GIS training and support.

Gwich'in Tribal Council
Howard Townsend

Hemmera Envirochem
Bill Gowdy, P.Geol. for his enthusiastic involvement in the mapping project.

Lodgestones Associates
Duane Good Striker for providing me with a sensitivity towards aboriginal tradition and values.

Sturgeon County
Regan Lefebre, **David Dmytryshyn** and **Frank Schoenberger** for providing the opportunity to observe the proceedings of the Area Structure Plan.

Sustainable Resource Development
Dr. Bob Fessenden, **Craig Quintilio**, **Glenn Selland**, **Val Hoover**, and **Dan Grahn** for granting education leave to conduct the research, **John Telder** for preparing the figures of Chapter 5, and **Marc Cadrin**, Geol.I.T., **Joanne Sweeney** and **Ian Hancock** for covering off the workload while I was on leave. **Charles Lendzion** for his assistance with the mapping project. **Gilman Cardinal**, **Bruce Mayer**, and **Lorne Ternes** for their guidance on aboriginal affairs.

USGS
Bill Langer for the wealth of information on aggregate resources.

University of Alberta
Dr. John England, **Dr. Sam Frimpong**, P.Eng., **Dr. Teresa Gavin**, **Dr. Denise Young**, and **Dr. Nat Rutter**, P.Geol. **Kimberly Arndt**, **Judy Fjoser**, **Elsie Tsang** for providing the administration support.

University of British Columbia
Marcello Viega, **Malcolm Scoble**, P.Eng. **Sandy Laird**, P.Eng. and **Bern Klein** for providing the opportunity to audit the Surface Mine Design 410 course.

University of Cincinnati
Robert Burnham

University of Hawaii
Dr. Luciano Minerbi, Dott. Arch, **Dr. Majid Tehranian** (Toda Institute), and **Dr. Peter G. Nicholson**, P.E. for empowering the vision of sustainable development to a global level.

Vision In Action Corp.
Derek Marriott for integrating the research into an assessment of Alberta government's role as the manager of the aggregate resources.

Amanda Brahn, Rev. **Patrick Cameron**, **Holly Leblanc**, **Marcia Lee**, **Sandra Myers**, Rev. **Kay Patrick**, **Chris Peel**, **Paul Peel**, **Terri Rambold**, **Doug Soprovich**, **Peter Windell**, and everyone else who provided me with input and moral support, **Sarah Huemment**, **Randy Revell**, (Context Associates-Washington), **Chuck** and **Lency Spezzano** (Psychology of Vision-Hawaii) for innovative leadership direction.

Introduction

> "*First you give the tree little shells or little black stones; then you raise your hands and talk 'Thank you tree. I have come to cut some bark so I can make my baskets. I'll only take what I need' ... we didn't just take it from any tree... we used to get it from the east side of the tree where the sun comes up. And you only take a strip, so that the tree still lives – then it heals up.*" Susan Lazzar, 1986 (Peers, 2001, p.2)

This quotation of a T'Sou-ke native describes how the T'Sou-ke, a First Nations tribe, extracted resources from the healthy lush rainforests of Vancouver Island. The T'Sou-ke practiced such rituals even though the wealth of the land and sea provided the tribe in such abundance they were envied by anyone who witnessed their environment (Peers, 2001). The sensitivity the natives had with the environment appears to be an innate tendency towards survival or "sustainable development". Other aboriginal cultures also appeared to have resource extraction practices that promoted sustainable yields. The Cree refer to living in peaceful co-existence with the land as "Sagow Pematosowin" (Syncrude Canada Ltd., 2001).

> *"Indigenous peoples are the base of what I guess could be called the environmental security system. We are the gate-keepers of success or failure to husband our resources. For many of us, however, the last few centuries have meant a major loss of control over our lands and waters. We are still the first to know about changes in the environment, but we are now the last to be asked or consulted....*
> *...The most we have learned to expect is to be compensated, always too late and too little. We are seldom asked to help avoid the need for compensation by lending our expertise and our consent to development."*
> Louis Bruyere 1986 (The World Commission on Environment and Development, 1987, p.61).

The phenomenon of human activity altering the environment of the Earth is a subject that has captivated the social consciousness of the developed nations. A majority of the people, ranging from scientists to inquiring children, are focusing their attention on the ever increasing number of environmental concerns such as oil spills, ozone depletion, global warming, endocrine disruptors, genetically engineered organisms, to name a few. These concerns stem from our ability to alter natural processes in our quest for a better

way of life. Paradoxically, in the process of using the natural resources to better our existence, the associated side effects appear to threaten our quality of life. The media has a tendency to focus on controversial issues surrounding sustainable development (e.g. Kyoto Protocol) while ignoring the headway being achieved through a wealth of ongoing collaborative initiatives and research. This unbalanced coverage leads the public to conclude there is little hope for the sustainability of our Earth in its present state. Is the destiny of the Earth controlled by natural forces, as witnessed in the apparent evolution of life forms, or will our ability to be conscious of change allow us to control our own destiny?

Modern society, with its expanding populations, is consuming the resources at a rate never before encountered. Climate change has been linked to greenhouse gas emissions and is being magnified by the expanding world populations. To respond to the apparent negative human-induced environmental impact, the United Nations has been promoting the philosophy of *sustainable development: 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs*" (The World Commission on Environment and Development, 1987, p.8).

In the publication *Global Environmental Change* (National Research Council, 1992), an interdisciplinary team of scientists under the title of the Committee on the Human Dimensions of Global Change made a number of recommendations related to the need for increasing research activities into human dimensions of global change. Climate change has become an area of focus that is consuming billions of research dollars with little evidence of tangible advancement toward sustainable development.

This thesis postulates, from the economic geology discipline perspective, that great advances towards sustainable development can be achieved through the application of sustainable development principles to the aggregate resource sector, a sector that has not attracted much scientific scrutiny. The cornerstones of sustainability: economy, environment, community, and a recently added one, governance (Richards, 2002a), will be examined in their relationship to the aggregate resource sector to identify the areas of opportunity.

Research on sustainable development information was conducted by a professional geologist who has been involved in a Provincial regulatory role of the

aggregate industry for the last 13 years. Various initiatives instigated by industry, the United Nations, local municipal agencies, government (federal and provincial), and the public were monitored and assessed for applicability to the aggregate resource sector. Personnel involved with the aggregate resource sector were surveyed to document the regulatory and business issues of the sector.

Close links with key staff in Alberta Environment, Sustainable Resource Development, Transportation and the Alberta Geological Survey were established. A connection to the University of British Columbia's Sustainability Working Group (Mining Engineering) was also gained through auditing Mining Engineering's Surface Mining 410 class. Other course work included Dr. Gavin's *Environment and Health* (EAS 494) and two Reading and Seminar courses (EAS 520). *"Sustainable Development" Applied to the Aggregate Industry* was the subject of the first EAS 520 course, evaluated by Dr. Richards, and *Quaternary Geology of Central Alberta and its Application to Aggregate Resources* was the topic of the second course, which was directed by Dr. Fenton and co-evaluated by Dr. Fenton and Dr. England.

The proposed research included a mapping project to amalgamate aggregate resource data held by a number of government agencies (Transportation, Environment, Energy, SRD, and the AGS) into a GIS database. ESRI's ArcGIS I and II courses were attended to familiarize the author with the GIS tools.

The research activities and results were presented at the Canadian Institute of Mining, Metallurgy and Petroleum's (CIM) 2002 Annual Conference (Vancouver), the 2002 Western Inter-University Geological Conference (Edmonton), the 2002, 2003, and 2004 General Annual Meetings of the Alberta Sand & Gravel Association, the 39th Forum on The Geology of Industry Minerals (Nevada, USA, 2003), the CIM 2004 conference (Edmonton), and to a number of University of Alberta undergraduate classes.

Two publications were generated from the research. *The Application of Sustainable Development Principles to the Alberta Aggregates Resource Sector* (Richards and Peel, unpublished) is to appear in the fall 2004 special edition of Exploration and Mining Geology (Geological Society of CIM) and *The Application of Mining, Minerals, and Sustainable Development's "Seven Questions of Sustainability" to a Planning Process in Alberta* (Peel, 2004) is available as a technical paper from the

proceedings from the 2004 conference. Excerpts from the thesis have been used in *Aggregate Resources Assessment Project* report (Marriott et. al., 2004), describing government-wide resource data.

The research project has been supported and sponsored by the Alberta Sand and Gravel Association (ASGA), the University of Alberta, and Alberta Sustainable Resource Development (SRD).

Chapter 1 Sustainable Development

Geoscience: an Essential Component to Sustainable Development Initiatives

Understanding the Earth's physical dynamics is essential to the formulation of sustainable development practices, and therefore geoscience can play a leadership role. The Earth can be viewed as a system made up of many subsystems with energy exchanges. James Hutton (1727-1797), considered the founder of geoscience, described the upper part of the Earth as a recycling system in which igneous, metamorphic and sedimentary rocks are constantly transformed from one to another (Bunce and Hunt, 1987). The atmospheric and water cycles also interacted with the rock cycle to introduce yet another system called life. Through the increasing primitive life populations, the Earth began to take on new unique environmental conditions. One could infer that the first forms of life, primitive bacteria and photosynthetic algae, were the first polluters as they pumped oxygen into the carbon dioxide-rich atmosphere to set the stage for aerobic life. This unconscious act was at the expense of the primitive anaerobic organisms' own existence.

The unconscious process began with the formation of the Earth. Geological history documents an evolution from a lifeless, churning, hot, molten, homogeneous planet to an organized planet with multiple systems including life of countless variations. Over the span of 4.5 billion years the Earth has experienced many shifts in environmental conditions. One of the first physical changes was likely the specific gravity segregation that structured the planet with a dense semi-metallic core, surrounded by a lighter mantle, capped by a yet lighter crust, partially covered by the water bodies, all enveloped by the gaseous atmosphere (Press, Siever, and Best, 1997).

Each physical change has been the result of the introduction of new components spawned by a maturation of the existing system. As an example, when microorganisms were introduced to the matured landmasses, their byproduct, soil, allowed the plant life to proliferate. Such new components are a catalyst to shift the flow of energy within the system. It is these changes in energy flow, made at an unconscious level, which creates new environmental conditions. In turn the new environmental conditions set the stage for the next evolutionary step.

Dr. Lovelock (1988) postulated in his book *The Ages of Gaia* "that the temperature, oxidation state, acidity, and certain aspects of rocks and waters are kept constant, and that this homeostasis is maintained by active feedback processes operated automatically and unconsciously by the biota" (Lovelock, 1988, p.19). Lynn Margulis added a dimension to the Gaia theory through her concept of *endosymbiosis*, which suggests that organisms living in a mutually beneficial relationship, are the driving force behind evolution — an alternative to Darwin's concept of survival of the fittest (competition). Systems theory suggests that in an environment of turbulent change and competition, the entity that can absorb the most information, learn from the information most thoroughly, and respond most nimbly, creatively, and flexibly will be the most adaptive (Goleman, 1998). The Gaia theory proposes the Earth as a self regulating environment and the planet itself is the core of a single, unified, cooperating, and living system; a super organism that regulates physical conditions to keep the environment hospitable for lifeforms. The Earth is a system in which the whole is greater than the sum of its parts (Lovelock, 1988).

The theory goes on to postulate that human intellectual capabilities are the result of the evolution of consciousness. Humans have become the nerve system that detects environmental change through a conscious understanding of the systems. From this understanding, humans can perhaps maintain the environmental balance. The evolution of the human brain can be viewed as the intellectual foundation for the development of a utopian environment for human survival. The sensitivity that the aboriginals display in respecting their connection to nature for survival appears to be the first appearance of consciousness towards the planet as a living entity.

To add to this notion, there is growing concern that the health of this planet is being jeopardized, and there is an abundance of information linking human activity with evidence of environmental instabilities or degradation. This presents a large opportunity for geoscientists to promote prescriptive procedures that could reduce this perceived impact. Due to the infinite variabilities of the multitudes of evolving systems interacting with one another and the amounts of data being generated by the many scientific disciplines, the solutions will most likely be developed through a collaborative union of the sciences. The term Geophysiology, coined by James Hutton, is touted as the proper

study of the Earth (EarthBirth Research, 2003); therefore, all integrated multi-disciplined research toward building sustainable development models, could be classified under this term. The concept of interdisciplinary collaboration is another example of how a system becomes greater than the sum of the parts.

Recent research has postulated that human industrial activity is triggering another environmental change in the form of "global warming". This is an example of an environmental change that has been consciously perceived, and through this awareness, measures may be developed and implemented to maintain the present conditions. Another example is our understanding of extra-terrestrial activity, which may lead us to develop nuclear missiles that protect the Earth from being hit by large meteorites. This awareness or consciousness, apparently unique to humans, has been generated through our ability to observe and evaluate the Earth's dynamic systems.

Sustainable Development Formulation

The 1960s heralded a doomsday message that human interaction with the environment is destroying the ecosystems on the Earth. *Silent Spring* by Rachel Carson (1962) appears to be the first publication that reconnected the public to their innate duty towards stewardship of the resources, a trait that the aboriginals appear to possess. From this capture of public consciousness, political agendas started to address the imbalance between human activities and the planet.

The United Nations held its first Environmental Conference in 1972 from which the United Nations Environment Programme was established. The WCED was tasked with "a global agenda for change" (Clarke, 2002).

In 1983, the United Nations, appointed an international commission chaired by Norwegian Prime-Minister Gro Harlem Brundtland. The Brundtland report, entitled *Our Common Future* (The World Commission on Environment and Development, 1987), introduced the concept of sustainable development, which is now the basis of many projects striving to achieve a balance between the biota and the environment. The publication refers to the Earth "*as an organism whose health depends on the health of all of its parts*", and concludes that "*humans have the power to reconcile human affairs with natural laws and to thrive in the process.*" (The World Commission on Environment and Development, 1987, p.1) *"In the broadest sense, the strategy for sustainable development*

aims to promote harmony among human beings and between humanity and nature " (The World Commission on Environment and Development, 1987 p.65). Specific to the non-renewable resources "*sustainable development is a process of change in which exploitation of resources, the direction of investments, the orientation of technical development, and institutional change are all in harmony and enhance both current and future potential to meet human needs and aspirations*" (The World Commission on Environment and Development, 1987, p.46). The report mentions the special attention required for tribal and indigenous peoples whose life-styles are disrupted through the forces of economic development; life-styles that offer modern societies valuable lessons in ecosystems management. The report concludes that many changes are required to achieve sustainable development, changes that are beyond the reach of present decision making structures and institutions.

At the Earth Summit of 1992, the United Nations Conference on Environment and Development reaffirmed the Declaration of the United Nations Conference on the Human Environment (1972). Twenty-seven principles were proclaimed, most of which can be incorporated into the mining resource sector's and governments' business plans as ways to induce sustainable development.

In addition to the establishment of the principles, all the participating 179 countries signed treaties on biodiversity and climate change, and adopted "*Agenda 21*". Agenda 21 (1992) is a blueprint for sustainable development, the concept of economic growth while protecting the natural resources. Agenda 21 contains 40 chapters under four sections. Of most relevance to the mining sector, Chapter 10 deals with the principles of planning and management of the land resources. The "integrated approach to the planning and management of land resources" outlined in Agenda 21 (1992) calls for the following "activities":

a) *developing supportive policies and policy instruments,*
b) *strengthening planning and management systems,*
c) *promoting application of appropriate tools for planning and management,*
d) *raising awareness,*
e) *promoting public participation,*
f) *strengthening information systems, and*
g) *strengthening regional cooperation and exchange of information on land resources* (UNCED, 1992, Sections 10.6 to 10.12)

The report notes "*No longer can social, economic and environmental development be seen as separate issues, their interdependence has become clearly established*" (Agenda 21, Chapter 1.1). Therefore, due to the mineral industry being deemed as essential to human welfare (The World Commission on Environment and Development, 1987, p. 16), each of these activities should be applied to the mining sector. The potential of mineral development has to be considered in the context of social, economic, and environmental aspects.

To assist in the implementation of Agenda 21 for developing countries and countries in transition, the United Nations Development Programme (UNDP) launched *Capacity 21* (1992). Through Capacity 21 the UNDP helped shape the agenda for the World Summit on Sustainable Development 2002, a review of the progress made in ten years since the Earth Summit. The Commission on Sustainable Development also initiated regional roundtables to prepare for the 2002 Summit. The Regional Roundtable for Europe and North America was held June 2001 in Vail, Colorado, USA. The 26 Roundtable delegates from North America and Europe focused on five areas of challenge: the need of a new development model, consumerism, resource depletion and waste, climate change, and institutions to support sustainable development (Regional Roundtable for Europe and North America, 2001). Article 13, the report from the Roundtable, comes with a message of urgency stating that the present generation may be among the last to be able to correct our path from the "point of no return". A proposal for action applicable to the aggregate mining sector, under a new development model of economic, social, and environmental integration is:

- *Urban systems are the greatest drivers of socio-economic activity as well as generators of immense pressures on the environment. They should be planned and operated as integral parts of the overall system* (Regional Roundtable for Europe and North America, 2001, p.5).

Under the area of resource depletion and waste the proposals for action most applicable to the aggregate resource sector are:

- *The capital costs of the depletion of natural resources and waste generation should be included in commercial and national accounts and in indicators used by decision-makers.*

- *Preventative strategies need to be developed to mitigate the risk of collapse of energy, land and water supply systems, as well as providing for long-term, effective methods of waste disposal. Particular attention should be paid to critical thresholds and irreversible effects in natural systems.*
- *The concept of industrial ecology should be fostered in any significant development.*
- *Tacit and indigenous knowledge needs to be tapped, as well as expert scientific knowledge, to assist full understanding of resource and eco-system management and sustainable use.*
- *Demand-side management should be applied, not only in the energy sector but with regard to water, land and forests.*
- *Mechanisms that induce cities and regions to establish partnerships to manage water and other resources in a sustainable manner need to be created.* (Regional Roundtable for Europe and North America, 2001, p.6)

Under climate change:

- *Focus first on domestic measures. Create mechanisms that persuade cities, local authorities, and corporations among others to set their own targets, select their own criteria and create alliances for action to reduce emissions and save energy. Publicise the resulting monetary and energy savings and advertise and reward their successes* (Regional Roundtable for Europe and North America, 2001 p.7) .

A new level of commitment, responsibility, and partnership is required to motivate people into action. Recognition of the health and carrying capacity of the natural environment has to be the basis of new ethical standards respecting the rights of forthcoming generations. There is a need to understand the philosophies of aboriginal societies, and to reconnect our children to the natural world and their capacity for positive action.

Working in parallel with the Brundtland Report, in 1987 the United Nations World Commission on the Environment called for the creation of a charter that would outline the new ethics of sustainable development. By 1997 an "Earth Charter" Commission was formed to oversee the formulation of the Earth Charter, which was launched at the Peace Palace in The Hague on June 29, 2000. The Charter has been endorsed by 12,593 (as of December 28, 2003) organizations, groups, and individuals world wide and the website (http://www.earthcharter.org/) invites any individual, group,

or organization to adopt the Charter and be added to the list. The "Earth Charter" (2003) outlines 4 principles:

> ***I. Respect and care for the community of life.***
> ***II. Ecological integrity.***
> ***III. Social and economical justice***
> ***IV. Democracy, nonviolence, and peace*** (The Earth Charter Initiative, 2003).

Among these principles, the Charter calls for management of "*the extraction and use of non-renewable resources such as minerals and fossil fuels in ways that minimize depletion and cause no serious environmental damage*" (The Earth Charter Initiative, 2003, p 3). To date it appears no mineral resource development companies have formally endorsed the Charter.

As an outcome of the World Summit on Sustainable Development conference (2002), the Johannesburg Plan of Implementation (WWSD, 2003, Chapter 46) identifies mining as an important activity, which can contribute to sustainable development initiatives. The World Mining Ministries Forum (WMMF, 2004) and the Global Dialogue of Governments on Mining/Metals and Sustainable Development (GDGMSD, 2004) appear to be representing the mining sector's continued involvement.

Canadian Government-Led Initiatives

The Canadian federal government has made a commitment to sustainable development by implementing the Green Plan (Government of Canada, 2003) and creating the House of Commons Standing Committee on Environment and Sustainable Development. This Committee recommended the establishment of a Commissioner of the Environment and Sustainable Development, who would be independent of government. The Commissioner of the Environment and Sustainable Development was legislated through the Auditor General Act in 1995, and has the mandate of making government accountable for "greening" its policies, operations, and programs by:

1. *reviewing how well government policies, programs and spending support Canada's move towards sustainable development; and*
2. *providing liaison, monitoring, and encouragement to government, parliamentarians, and the public on sustainable development* (Government of Canada, 2001).

The Commissioner monitors the extent to which sustainable development strategies have been implemented by 25 federal departments and prepares annual reports to the House of Commons. The Commissioner also receives petitions from the public regarding questions related to environment and sustainable development issues. The government agencies required to prepare sustainable development strategies have responded.

Environment Canada has implemented the "Sustainable Development Strategy" in which the department claims to be in a position to provide leadership "*in building an agenda and in mobilizing Canadians to make sustainable development a reality*" (Environment Canada, 2003a, Section 1.2). Strategy 2 gives priority in building partnerships with aboriginal people "*to set environmental quality standards and promote integration of environmental considerations in Aboriginal self-government and land claim agreements*" (Environment Canada, 2003b).

The priority for partnership also initiated the *Canada-Wide Accord on Environmental Harmonization*, which has provincial representation through the Canadian Council of Ministers of the Environment (CCME, 2003). A broad objective of the partnership is to promote sustainable development.

Industry, Science and Technology Canada adopted the mandate to develop new partnerships among government, industry, and science representatives in search of scientific knowledge and technology for efficient use of resources (Industry, Science and Technology Canada, 1991). Natural Resources Canada released an "issues paper" entitled *Sustainable development and Minerals and Metals* in 1995. "Our Strategy for the Future" (Natural Resources Canada, 1998) outlined a number of principals as a guide to achieving the Brundtland (The World Commission on Environment and Development, 1987) definition of sustainable development: "*development that meets the needs of the present without compromising the ability of future generations to meet their own needs*"

In 1992, the Alberta provincial government implemented sustainable development initiatives starting with the Legislative Assembly adopting Alberta's Round Table on the Economy and Environment vision statement: "*Alberta, a member of the global community, is a leader in sustainable development, ensuring a healthy environment, a*

healthy economy, and a high quality of life in the present and future" (Alberta Round Table on Environment and Economy, 1991). In 1999, the document entitled "Alberta's Commitment to Sustainable Resource and Environmental Management" (Alberta Government, 1999a) outlined methods for implementing the Province's vision. The paper describes a body called the "Sustainable Development Coordinating Council" which consists of the Deputy Ministers of the lead departments managing natural resources and the environment. The Deputy Ministers will be held accountable for the integration of all government programs through the Council.

The Implementation Plan (Alberta Government, 1999b) for the Commitment was drafted by the Integrated Resource Management Implementation Committee. This Plan states that sustainable development will be achieved through "Integrated Resource Management", a concept found in Agenda 21. Other initiatives include "Sustaining Alberta's Biodiversity" (Alberta Environment, nd) which commits the provincial government to the "Canadian Biodiversity Strategy" (Government of Canada, 2000), and the creation of the department of Sustainable Resource Development (SRD) in 2001. This department has the mandate of managing a number of the province's natural resources (fish, wildlife, forests, rangelands, and surface materials), while still allowing for responsible economic development (Alberta Environment, 2001). Similar to the federal auditor (the Commissioner of Environment and Sustainable Development) the Alberta government reports annually, to the Auditor General, on the progress towards sustainable development.

The Alberta Government's 2002-03 Annual Report contains a Performance Summary categorized under the headings of People (equates to "community" in the context of sustainable development), Prosperity ("economics"), and Preservation ("environment"). Each category has a number of goals, which are reported through associated measures, targets, current results, and previous results. The report can be viewed on the World Wide Web at http://www3.gov.ab.ca/srd/dept/reports/annual/2002-2003_Annual_Report.pdf).

Specific to the aggregate resources, the Alberta Government has endorsed the *Alberta Mineral Development Strategy 2002* (Alberta Government, 2002c), in which

there is the recommendation to initiate a separate similar strategy development process for the sand and gravel resources.

Industry-Led Initiatives

The Mining Association of Canada (MAC) instigated the Whitehorse Mining Initiative (WMI) in 1994 to develop a new strategic vision and to create solutions for the 21st century. Five sectors of society including the mining industry, senior governments, labour unions, Aboriginal peoples, and the environmental community agreed to the Accord. This was the result of a three-tier organization consisting of the Leadership Council, which provided high level direction and accountability, a Working group that handled the funding, planning and monitoring of work, and four Issues Groups to define and address issues along with recommendations. The Issues Groups consisted of Finance/Taxation, Environment, Land access, and Workforce/workplace/community. The vision of the initiative is to ensure mining continues to make an important contribution within the context of sustainable development. The Accord contains 16 principles and 65 goals and was endorsed by the Leadership Council Members. (WMI, 1994). The 1996 Progress Report indicates all provincial governments have endorsed the accord, with the exception of Alberta and Quebec (WMI, 1996).

Nine international mining companies launched the Global Mining Initiative (GMI) in 1998 to redefine the role of the global mining industry in relation to sustainable development. With the United Nations' World Summit for Sustainable Development 2002 conference in mind, the GMI created an industry network that focused on sustainable development, initiated an independent analysis of the mining sector, and conducted a global conference in May of 2002 (ICMM, 2004).

The International Institute for Environment and Development (IIED, London) was commissioned to conduct an independent survey of the mining sector on behalf of the World Business Council for Sustainable Development (WBCSD). The IIED (London) managed the independent two-year consultation and research initiative known as the Mining, Minerals and Sustainable Development (MMSD) Project. The final report of this project "*Breaking New Ground: Mining, Minerals, and Sustainable Development*" was

published by IIED (2002a), and contains an analysis of the issues faced by the mining industry with an outline of a framework for change.

The initiatives undertaken by the GMI helped establish a clear understanding of the positive role the mining and minerals industry can play in making the transition to sustainable patterns of economic development, which was conveyed at the World Summit. The formation of the International Council on Mining and Metals (ICMM) was another positive outcome of the GMI.

In addition, to enhance the effectiveness and efficiency of the MMSD project the task was divided into regional divisions. MMSD North America was facilitated by the International Institute for Sustainable Development (IISD, Winnipeg) assisted by the Mackay School of Mines, University of Nevada (IIED, 2002b). Numerous regional reports have been released, several specific to North America. The last conference of the Initiative was held in Toronto in May of 2002 drawing 20 CEOs from mining companies around the world, 25 mining related government officials, along with 74 non government organizations including academic participants.

The "*Seven Questions to Sustainability – How to Assess the Contribution of Mining and Mineral Activities*" (IIED, 2002c) was the product of the North American MMSD through a number of workshops, which included a diverse representation of stakeholders from First Nations to international mining companies. The assessment appears to be applicable to any mining activity including the aggregates resource sector, which has mostly eluded the established mining community's attention. Assessment of this sector merely by examining its local, regional, and global consumption rates is indicative of the sector's significance to the sustainability equation.

Academia-Led Initiatives

The Geological Society of the Canadian Institute of Mining and Metallurgy's (CIM) NUNA 2001 conference created an initiative to pursue the funding of research on sustainable development in the mineral industry. The initiative attracted and showcased existing research projects to the "Sustainable Mining in the 21st Century" (SUM21) conference in Vancouver, B.C. May 2002. This conference was co-sponsored by the Geological Society of the CIM, The Geological Association of Canada (Mineral Deposits

Division), The Society of Economic Geologists, Prospectors and Developers Association of Canada, and the Canadian Geoscience Council (CGC).

After 16 various research projects were presented, delegates collaborated in striking a course to "*identify the role (s) that geoscientists can play within a broadly-based program in sustainable development research, and to develop the elements of a program proposal*" (Richards, 2002b). Adding strength to this initiative, the CGC appointed the organizers of the NUNA 2001 and SUM21 conferences as a CGC Standing Committee. The mandate of the committee is to "*facilitate and promote sustainable mining for the benefit of Canadians by finding ways to incorporate geoscience in a wide range of relevant research and development*" (CIM, 2003). The promotional function was effectively conducted through the Yellowknife Geoscience Forum, November 2002, and the GAC-MAC-SEG joint meeting in Vancouver, May, 2003. The University of British Columbia Mining Engineering's "*Sustainability Working Group*" planned and facilitated, "*Walking the Talk*" as a follow up to the MMSD project, at CIM's 2003 Annual General Meeting (Sustainability Working Group, 2003). To date, through the activities of CGC's Standing Committee members (CGC, 2003) and their affiliations, the initiative is linked to numerous academic, government, and industry organizations, including GAC, CIM, SEG, the Natural Sciences and Engineering Research Council of Canada (NSERC), the Geological Survey of Canada (GSC), PDAC, CAMIRO, Barrick Gold Corp., Inco Ltd., Falconbridge Ltd., Noranda Ltd, SRD, and the Alberta Sand and Gravel Association.

All these initiatives, with the exception of the SUM21 conference, relate to the mining industry with emphasis on the international, metallic, and energy resource mining operations without reference to the aggregate resource extraction operations. At SUM21, the uniqueness of the aggregate resource sector in the context of sustainable development was identified.

Aboriginal-Led Initiatives

Due to the reference to aboriginal involvement as a principle of sustainable development (Rio Declaration and Agenda 21), along with the active land claim issues now facing Canadians, initiatives led by aboriginal involvement are of prime importance

to any path towards sustainable development. The following examples of aboriginal initiatives were found through a World Wide Web search.

In response to Agenda 21's Chapter 26, a confederation of North American indigenous people referred to as the "Six Nations" (Seneca, Cayuga, Onondaga, Oneida, Mohawk, and Tuscarora) or Haudenosaunees, formed the Haudenosaunee Environmental Task Force (HETF). In 1995, HETF presented the *Haudenosaunee Environmental Restoration: An Indigenous Strategy for Human Sustainability* (HERS) to the United Nations at the Summit of the Elders (HETF, 2001). This is an example of developments within the North American aboriginals. Other websites related to organizations such as National Tribal Environmental Council, the National Tribal Environment Research Institute, Assembly of First Nations, offer aboriginal perspectives and involvement on environmental issues.

In Canada, the *First Nations Land Management Initiative* (2003) offers a number of Canadian aboriginal nations *the opportunity to develop their own modern and/or traditional tools to manage and protect their reserve lands and resources* (Indian and Northern Affairs Canada, 2004). Many developments that relate to sustainable development may be created through such programs and is an important area to monitor.

Summary and Conclusions

The concept of sustainable development, proposed by the United Nations and outlined in *Agenda 21*, appears to be a viable path to maintain the environmental health of the Earth. Because the concept integrates many perspectives, input from many disciplines such as computer technology, biology, geology, economics, etc., is requires to arrive at all-encompassing solutions. Because of the environmental and resource use aspects of sustainable development, the initiative is an opportunity to engage Earth scientists as leaders, who collaborate with key disciplines, to innovate effective practices that promote sustainability.

Many projects and programs are being conducted under the banner of sustainable development by a wide variety of organizations ranging from local, national, to international, stemming from cultural origins, industry initiatives, to government driven. Due to the diversity and number of initiatives, obtaining pertinent information and keeping abreast of the developments in this research area, is a full time occupation. Also,

contributing research data into the domain requires being cognizant of, and being connected to, the trend setting organizations. Because a principal of sustainable development calls for aboriginal input, aboriginal initiatives or initiatives that have aboriginal involvement are likely to be the most viable for networking with or building on.

The mining industry has well-established initiatives, which include aboriginal involvement. However, with the number of networks being established, it is difficult to determine which mining sector initiatives or organizations are creating the best synergy, amongst the disciplines, to advance the research most effectively. The Mining Association of Canada's *Towards Sustainable Mining* (TSM) initiative launched at the CIM's 2004 annual conference, the CGC's *Sustainable Mineral Resources Development Committee*, and UBC's *Sustainability Working Group* (Costa and Scoble, 2003) appear to be leading edge research networks in Canada. Internationally, the International Institute for Sustainable Development (IISD) and the ICMM appear to the best global networks of leading sustainable development organizations whom collaboratively advance research in the field of sustainable development. The IISD has implemented the "*Sustainable Development Communications Network*" (SDCN) to accelerate the implementation of sustainable development by informing a broader audience about sustainable development and keep the member organizations informed of research developments (IISD, 2000). The *Earth Negotiations Bulletin* is another networking service of the IISD to convey daily information on environmental and development negotiations to participants at United Nations negotiation meetings (IISD, nd).

Chapter 2 The Relationship Between Aggregate Resources and Sustainable Development

Academia, government, and public seldom give recognition to the globally highest consumed material, mineral aggregate, for its role in community development and economic stability. When the sector does attract attention, it is usually in the form of public opposition, which may result in the forced relocation of extraction operations to more remote areas.

Learning institutes seldom teach future geoscientists, economists, planners, or environmentalists the strategic importance of aggregate resources. As a result:

- land use decisions seldom include aggregate resource inventory data;
- most other resources take priority in land use or conservation decisions; and
- environmental impact assessments of major projects usually do not include the aggregate resource requirements and the identification of where they are to come from, along with the environmental impact of the resource extraction.

Due to this lack of consideration in planning processes, there are many areas for improvement in the management of the aggregate resource sector, especially in the context of sustainable development. Sustainable development involves finding a balance between the economic, environmental, and social considerations; therefore, analyzing the relationship of the aggregate resources to these considerations provides a mechanism for identifying areas of opportunity.

Economic Considerations of Mineral Aggregate Production

Usage and Economic Effects

Aggregate is used globally as a cost-cutting filler and strengthening additive in structural materials. This usage of the resources is a significant economic factor because this material provides the infrastructure upon which most development occurs (e.g., oilsands, timber, urban) and business is conducted (e.g., trade corridors). A breakdown of usage for different parts of urban and rural infrastructure is shown in Figure 1.

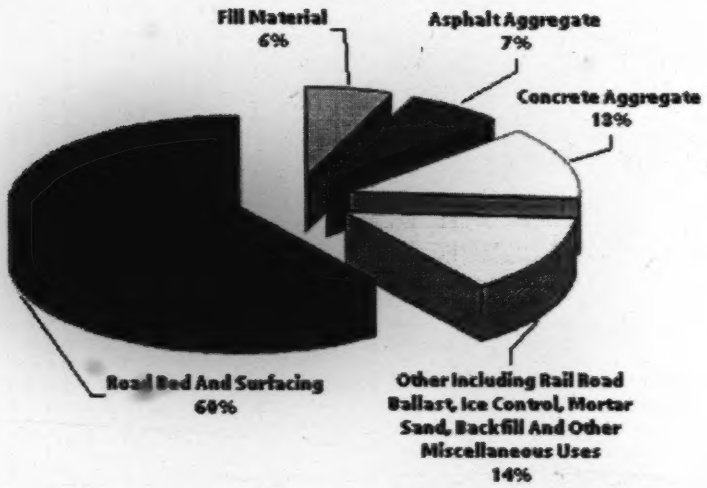

Figure 1: Aggregate usage (Rock Quarry and Marine Loading Facility, 2004)

The first major use of aggregate assisted the evolution of society by the development of road networks. The Romans consolidated their empire by building roads to the lands they conquered (Dunbar, 2003). The road system became an economic benefit through providing a method of transporting goods, services, and people between communities and cultures. "*Transportation critically affects the productivity and performance of any business that uses it. Transportation enables our economic wealth and the tax base to pay for what is important to Canadians*" (Westac, 2002, p.4). The road networks also have military significance for defense strategies.

The North American Free Trade Agreement, a possible economic unification of three nations, is being supported by the CANAMEX road development to provide a transportation corridor between Mexico (south), five American states (Arizona, Nevada, Idaho, Utah, and Montana), and Canada (north). This development has significant growth implications and wealth-generating opportunities for all the participating communities. Alberta, the only Canadian province to be involved, has committed CDN$1.4 billion through to 2009 toward highway improvements (CANAMEX, 2003).

Because the largest volume of aggregate (>60%) is used for public funded construction, such as the development and maintenance of public transportation systems (from gravel roads to freeways, urban networks, and airport runways), obtaining the lowest unit price leads to a lower taxation rate. Presently, escalating costs in highway

construction projects are the subject of a number of international studies. The cost factor in repairing the deteriorating national road infrastructure is becoming a concern considering government budgetary trends (Westac, 2002; UNESC, 2001; CMRTHS, 1998).

Production Volumes

The magnitude of aggregate usage reflects the commodity's economic significance. In 1998, world production of mineral aggregates (sand and gravel, and crushed stone) amounted to over 19 billion tonnes (Wellmer and Becker-Platen, 2002), five times the production of any other mineral (see Table 1). The value attached to the 1998 sand and gravel production was € 97 billion (Euros) and € 23 billion for crushed stone (combined equals € 120.1 billion, or US$102.9 billion or CDN$8.35/tonne in 1998 dollars).

Of all the minerals, only coal (€122 billion), natural gas (€161 billion), and crude oil (€412 billion) exceed this combined value.

In a separate analysis, Regueiro et al. (2002) calculated annual world production of aggregate (assumed to be referencing the year of 2000) to be approximately 15 billion tons at a value of US $76 billion. The discrepancy between these estimates and those of Wellmer and Becker-Platen (2002) is "*due mainly to varying material definitions and categorisations and to imprecise data gathering systems*" (Harrison, 2003). However, both figures indicate very high consumption rates. In the United States, the construction materials and industrial minerals sector now constitutes over 80 % of the total materials flow and 48% of total mineral production values, and the numbers are growing fast (MacDonald, 2002).

Table 1: World Production of Mineral Resources in Quantity (ores given as metal equivalent, natural gas in million m^3) and Value for 1998 (Wellmer and Becker-Platen, 2002).

Mineral	Production (1,000 tonnes)
Diamonds	0.02
Platinum	0.35
Gold	2.5
Electronic metals	3.2
Silver	16
Cobalt	24
Columbium	26
Tungsten	32
Uranium	36
Vanadium	45
Antimony	118
Molybdenum	135
Mica	206
Tin	209
Magnesium	401
Kyanite and related materials	431
Zirconium	455
Graphite	648
Boron	773
Nickel	1,110
Asbestos	1,190
Diatomite	2,060
Lead	3,040
Chromium	4,080
Fluorspar	4,810
Barite	5,880
Zinc	7,470
Talc	7,870
Manganese	8,790
Feldspar	8,800
Bentonite	9,610
Copper	12,200
Peat	25,300
Potash	26,500
Aluminum	27,400
Kaolin	36,600
Sulphur	55,600
Gypsum Anhydrite	103,700
Rock salt	191,100
Industrial sand	300,000
Clay	500,000
Iron	562,000
Lignite	848,000
Natural Gas	2,357,000
Crude Oil	3,578,000
Coal	3,735,000
Crushed stone	**4,100,000**
Sand and Gravel	**>15,000,000**

Mineral	Value (million Euro)
Kyanite and related materials	54
Mica	69
Barite	120
Zirconium	130
Antimony	145
Tungsten	155
Graphite	194
Electronic metals	200
Aluminum	301
Titanium	345
Bentonite	388
Manganese	391
Talc	439
Diatomite	440
Fluorspar	576
Asbestos	618
Peat	659
Gypsum	669
Chromium	727
Magnesium	821
Uranium	852
Magnesite	864
Tin	918
Molybdenum	925
Cobalt	1,040
Boron	1,560
Silver	1,600
Manganese	1,610
Sulphur	1,820
Nickel	1,890
Zinc	2,980
Rock salt	3,080
Phosphate	3,140
Potash	3,510
Platinum	3,760
Kaolin	3,960
Diamonds	3,960
Industrial sand	4,910
Clay	5,500
Copper	9,500
Iron	15,200
Gold	20,900
Crushed stone	**23,100**
Lignite	30,300
Sand and Gravel	**97,000**
Coal	122,000
Natural Gas	161,000
Crude Oil	412,000

Production Values

In light of the volume of aggregate that is used in publicly funded construction, there should be an economic advantage to maintaining low aggregate resource production costs. Regueiro et al.'s (2002) figures give a resource value of $7.86/tonne (1998 CDN$) without differentiating between crushed stone and gravel. In comparison, Wellmer and Becker-Platen's (2002) figures indicate a unit price for crushed stone (aggregate) of $7.48/tonne, whereas sand and gravel have a value of $8.59/tonne (1998 CDN; converted using Federal Reserve Statistical Release, 1998). Wellmer and Becker-Platen's (2002) figures are at variance with the usual higher value of crushed stone due to the higher production cost. According to the Canadian 1998 production values (Table 2), the value of crushed stone always exceeds that of sand and gravel and overall is 72% higher.

There are many factors that affect the production value of aggregates, such as resource availability, property values, taxation rates, operating standards, competition, environmental restrictions, and social restrictions. Thompson (1980) assessed the effect of public opposition in terms of total aggregate production cost. He evaluated rural and urban operations in the United States, and found that a difference of up to US$1.89 (1980 dollars) per ton of aggregate (60% of the base price of the resource) could result from such conflicts, and that this effect was highest for operations close to urban areas.

Canadian Production and Production Trends

Canadian mineral production rates and values have been gathered since 1886 (Statistics Canada, 2000), however the aggregate resources were not individually categorized and reported until 1949-1950. Table 2 shows the provincial hierarchy based on production and unit price/tonne (assuming the lower production value is reflected in lower highway construction costs, subsequently less taxation requirements).

Table 2: Canadian aggregate production and value 1998 (Statistics Canada, 2003).

1998 Statistics Canada	Production rate (kilotonnes) Production Values	($'000) 1998 CDN	Unit price $/tonne		Rank in production 1=highest	Rank in Taxation advantage 1=highest
	sand and gravel	sand and gravel	sand and gravel	Combined		
	crushed stone	crushed stone	crushed stone			
Newfoundland	3714	17754	4.78	5.95	9	10
	2606	19837	7.61			
PEI	199	898	4.51	4.51	12	2
	–	–	-			
Nova Scotia	2400	10927	4.55	5.61	7	8
	7628	45348	5.94			
New Brunswick	4336	–	-	5.94	8	9
	3500	20796	5.94			
Quebec	27319	72414	2.65	4.83	2	5
	32220	215171	6.68			
Ontario	88186	325109	3.69	4.82	1	4
	50689	344707	6.80			
Manitoba	10315	-		5.00	6	6
	4992	24971	5.00			
Saskatchewan	12032	-	-	-	5	?
	-	-				
Alberta	43998	200823	4.56	4.62	3	3
	633	5362	8.47			

1998 Statistics Canada	Production rate (kilotonnes) Production Values	($'000) 1998 CDN	Unit price $/tonne		Rank in production 1=highest	Rank in Taxation advantage 1=highest
	sand and gravel	sand and gravel	sand and gravel	Combined		
	crushed stone	crushed stone	crushed stone			
B.C.	31908	161084	5.05	5.44	4	7
	6321	46995	7.43			
Yukon	690	2123	3.08	3.08	11	1
	-	-	-			
NWT	419	2009	4.79	8.97	10	11
	336	4760	14.17			
Canada	225338	875226	3.88	4.80		
	108924	727947	6.68			

Table 2 compares production rates across Canada and deduces the implied production value, per unit. Overall, Canada's unit price, $4.80/tonne, is lower than the global price of $8.35/tonne (1998). If all other cost factors were equal, the lower unit price would have given Canada a cost advantage over trade competitors in constructing and maintaining efficient highway networks for the transportation of goods. At this lower value, Canadian tax payers saved over $700,000 annually, given that >60% of the production is used in publicly financed infrastructure projects (road bed/surfacing, asphalt production, and ice control; Figure 1). Likewise, Alberta's 1998 unit price at $4.62/tonne (slightly below the national average), gave the province an advantage over other provinces, to establish and maintain trade efficient highway networks. Alberta's lower price was likely due to the availability to less costly sand and gravel extraction operations in comparison to the mining of bedrock sources.

Overall trends obtained by comparing historical production data are also likely to be informative. Table 3 shows the Canadian production price has risen 28% over a six-year period (1995-2001) with an increase of 5% of the production coming from the more costly crushed stone operations.

These statistics (Table 3) indicate that the overall Canadian inflation rate for aggregate production is 4.67%/yr. Despite the fact that the value of crushed stone is 71% greater than for sand and gravel, there is a trend towards increased crushed stone production (+5% between 1995 and 2001), to meet increasing resource demands.

Regional economic trends also become apparent by comparing how aggregate production varied between the provinces in 1995 and 2001. Alberta leads the country for increased sand and gravel production value (+44%) over the 6 year period. Ontario had the largest value increase in crushed stone production at 43%, but this figure is still 35% lower than Alberta's crushed stone value. Because Alberta's aggregate production is mainly from sand and gravel sources, Alberta ($5.84/tonne) also had a cost advantage over Ontario ($6.00/tonne). Nova Scotia's combined production cost ($6.25/tonne) is the national high followed by Ontario ($6.00/tonne). Five provinces have average production values above the national average of $5.59/tonne, including the three largest producers, Ontario, Alberta, and B.C.

Alberta's six-year value trend shows the provincial cost advantage slipped from 3rd place (1995) to 9th place (2001) when comparing the production values/tonne, even though the province had the lower extraction cost advantage through accessible sand and gravel sources (no increase in percentage of production coming from crushed stone).

Table 3 : Canadian aggregate production and value trends 1995-2001 (Statistics Canada, 2003)

1995 & 2001 Statistics Canada	Production rate (kilotonnes)	1998 CDN Values ($'000)	Unit price $/tonne	6 year Value Trend	National economic advantage	% of Canadian Production	Average Production value/tonne (2001)	% of total production from sand and gravel sources	Production trend towards crushed stone	Rank in taxation advantage (2001)	Rank in product-ion (2001)
	sand and gravel	sand and gravel	sand and gravel	sand and gravel	sand and gravel	sand and gravel					
	crushed stone	crushed stone	crushed stone	crushed stone	crushed stone	crushed stone					
Newfoundland	2181 (95) 2594 (01)	12027 (95) 10249 (01)	5.51 (95) 3.95 (01)	-28%	+12%	0.97 (95) 1.10 (01)	5.98	67% (95) 37% (01)	+30%	10	9
	1097 (95) 4390 (01)	9812 (95) 31522 (01)	8.94 (95) 7.18 (01)	-20%	+06%	1.11 (95) 3.52 (01)					
PEI	341 (95) 167 (01)	1621 (95) 781 (01)	4.75 (95) 4.68 (01)	-01%	-04%	0.15 (95) 0.07 (01)	4.68	100% (95) 100% (01)	unchanged	6	12
	–	–									
Nova Scotia	3436 (95) 2959 (01)	13511 (95) 14096 (01)	3.93 (95) 4.76 (01)	+21%	-06%	1.52 (95) 1.25 (01)	6.25	32% (95) 25% (01)	+7%	12	6
	7233 (95) 8749 (01)	39255 (95) 59028 (01)	5.43 (95) 6.75 (01)	+24%	+12%	7.34 (95) 7.01 (01)					
New Brunswick	5374 (95) 2529 (01)	– 9748 (01)	3.85 (01)		+14%	2.37 (95) 1.07 (01)	4.43	58% (95) 38% (01)	+20%	5	8
	3892 (95) 4204 (01)	22153 (95) 20073 (01)	5.69 (95) 4.77 (01)	-16%	+38%	3.95 (95) 3.36 (01)					
Quebec	29109 (95) 29487(01)	82736 (95) 85553(01)	2.84 (95) 2.90(01)	+02%	+35%	12.9 (95) 12.5 (01)	5.34	47% (95) 45% (01)	+2%	7	2
	32803 (95) 36436 (01)	197725 (95) 266536 (01)	6.03 (95) 7.32 (01)	+21%	+05%	33.3 (95) 29.2 (01)					

1995 & 2001 Statistics Canada	Production rate (kilotonnes)	1998 CDN Values ($'000)	Unit price $/tonne	6 year Value Trend	National economic advantage	% of Canadian Production	Average Production value/tonne (2001)	% of total production from sand and gravel sources	Production trend towards crushed stone	Rank in taxation advantage (2001)	Rank in product-ion (2001)
	sand and gravel	sand and gravel	sand and gravel	sand and gravel	sand and gravel	sand and gravel					
	crushed stone	crushed stone	crushed stone	crushed stone	crushed stone	crushed stone					
Ontario	90747 (95)	322254 (95)	3.55 (95)	+25%	+01%	40.2 (95)	6.00	69% (95)	+6%	11	1
	97878 (01)	433403 (01)	4.43 (01)			41.4 (01)		63% (01)			
	41683 (95)	252409 (95)	6.06 (95)	+43%	-13%	42.3 (95)					
	57969 (01)	501956 (01)	8.66 (01)			46.5 (01)					
Manitoba	11179 (95)	–	–		+33%	4.95 (95)	3.46	76% (95)	+1%	3	5
	10952 (01)	32982 (01)	3.01 (01)			4.63 (01)		75% (01)			
	3551 (95)	15020 (95)	4.23 (95)	+13%	+38%	3.60 (95)					
	3744 (01)	17837 (01)	4.76 (01)			3.00 (01)					
Saskatchewan	8313 (95)	–	–		+19%	3.68 (95)	3.65	100% (95)	Unch	4	7
	13195 (01)	48106 (01)	3.65 (01)			5.58 (01)		100% (01)			
	–	–									
Alberta	31207 (95)	112767 (95)	3.61 (95)	+44%	-29%	13.8 (95)	5.84	99% (95)	Unch	9	3
	44214 (01)	255313 (01)	5.77 (01)			18.7 (01)		99% (01)			
	466 (95)	4494 (95)	9.64 (95)	+21%	-53%	0.47 (95)					
	478 (01)	5599 (01)	11.71 (01)			0.38 (01)					
B.C.	39024 (95)	158192 (95)	4.05 (95)	+33%	-20%	17.3 (95)	5.72	84% (95)	+3%	8	4
	30687 (01)	165213 (01)	5.38 (01)			13.0 (01)		81% (01)			
	7204(95)	45942(95)	6.38(95)	+12%	+07%	7.31(95)					
	7212(01)	51412(01)	7.13(01)			5.78(01)					

1995 & 2001 Statistics Canada	Production rate (kilotonnes)	1998 CDN Values ($'000)	Unit price $/tonne	6 year Value Trend	National economic advantage	% of Canadian Production	Average Production value/tonne (2001)	% of total production from sand and gravel sources	Production trend towards crushed stone	Rank in taxation advantage (2001)	Rank in product-ion (2001)
	sand and gravel	sand and gravel	sand and gravel	sand and gravel	sand and gravel	sand and gravel					
	crushed stone	crushed stone	crushed stone	crushed stone	crushed stone	crushed stone					
Yukon	1120 (95)	3900 (95)	3.48 (95)	-15%	+34%	0.49 (95)	2.97	100% (95)	Unch.	2	11
	1226 (01)	3646 (01)	2.97 (01)			0.51 (01)		100% (01)			
	–	–									
NWT	3960 (95)	16040 (95)	4.05 (95)	+30%	-17%	1.75 (95)	2.86	86% (95)	+59%	1	10
	598 (01)	3143 (01)	5.26 (01)			0.25 (01)		27% (01)			
	649 (95)	4447 (95)	6.85 (95)	-71%	+74%	0.66 (95)					
	1577 (01)	3085 (01)	1.96 (01)			1.26 (01)					
Nunavut	0 (01)	0 (01)					00				13
	0 (01)	0 (01)									
Canada	225992 (95)	793489 (95)	3.51 (95)	+28%			5.59	70% (95)	+5%		
	236486 (01)	1062234 (01)	4.49 (01)					65% (01)			
	98578 (95)	591255 (95)	6.00 (95)	+28%							
	124758 (01)	957048 (01)	7.67 (01)								

*Values are computed on the f.o.b. shipping point basis and they represent, therefore, the amounts actually received by the producers. Values are adjusted to exclude cost of containers, taxes, duties, sales discounts, and outward-bound transportation (Statistics Canada 2000, p.22).

Table 4: Provincial ranking of taxation burden from aggregate usage for road construction (lowest to highest) per capita (2001 figures).

Province	Population (thousands)	2001 Consumption for roads (kilotonnes)	Consumption per capita (tonnes/person)	Cost per capita ($)
PEI	136.7	40.2	0.3	1.33
New Brunswick	749.9	4,039.8	5.4	23.86
Manitoba	1,151.3	8,817.6	7.7	26.50
Quebec	7,397.0	39,553.8	5.3	28.55
Saskatchewan	1,000.1	7,917	7.9	28.89
British Columbia	4,078.4	22,739.4	5.6	31.89
Nova Scotia	932.4	7,024.8	7.5	47.09
Ontario	11,897.6	93,508.2	7.9	47.16
Newfoundland	522.0	4,190.4	8.0	48.00
Alberta	3,056.7	26,815.2	8.8	51.23
Yukon	30.1	735.6	24.4	72.58
NWT	40.8	1,305	32.0	91.48
Canada	30,000	141,900	4.7	26.44

Table 4 shows Alberta's competitive advantage has been further compromised when comparing the aggregate resource cost for highway construction per capita. Alberta's cost for aggregate resource consumption towards road networks calculates to $156,600,768 (26,815,200 tonnes x $5.84/tonne) or $51.23/person, which is close to

double the national average ($26.44) or 10th highest for cost/capita. Alberta's economic trend for the cost of aggregate resources is likely a reflection of not incorporating aggregate resource potential values into the provincial and municipal planning processes (see Chapter 5), because development exceeded that of most other provinces.

Location

Although the Statistics Canada production value figures (Tables 2 to 5) do not include transportation costs for delivery, the distance the resource or product has to be transported is directly proportional to the price of the product. Therefore, the closer the resources are to the place of use, the cheaper they will be, thereby lowering construction costs. However there is a worldwide general trend that the public opposes extraction operations due to their disruptive activities. The "Not In My Back Yard" (NIMBY) phenomenon is created when rural and urban development planning fail to inventory and factor in the location of the aggregate resources, with the result that urban development occurs close to aggregate extraction sites. Closure of such sites by public opposition means that aggregate producers cannot access the closest resources, and therefore have to extract resources from further afield, with consequent increases in transportation costs. These transportation costs are a significant portion of the supply cost. "*The charge for haulage is the most influential factor in determining the cost of the final product at delivery point*" (Jefferson County, 2000). The community being served routinely absorbs such costs.

Environmental Considerations Related to Mineral Aggregate Extraction

Aggregate resource extraction and associated activities impact the land surface (e.g., fauna, flora, soil), air quality, and water resources. These various impacts are discussed below:

Land Disturbance

According to Alberta Environment sources the government has record of 5960 pits with an estimated surface disturbance of 260 sq km (Walls, 2001). Alberta's estimated aggregate volume demand for aggregates from 2000-2050 is 5 billion tonnes (Edwards 2001). Based on the average thickness of a gravel deposit of 3 m, this amount

of material is equivalent to 5.3 tonnes/ sq m surface disturbance or 0.94 billion sq m or 940 square kilometers of surface disturbance (0.14% of Alberta's total area). This does not include the associated disturbances such as road development or working spaces. In many cases these disturbances will:

- displace a variety of vegetation ranging from old growth forest to sparsely vegetated grassland;
- alter or temporarily disrupt a variety of wildlife habitat or ecosystems;
- lead to an overall loss of the growing medium's productivity through the stripping of the topsoil and subsoil;
- increase the potential of land erosion;
- increase the potential of increasing sediment loads associated with water runoff; and
- increase the risk of contamination of water resources through the removal of impermeable clay rich strata overlying sand and gravel deposits.

Although these effects appear problematic, many of the disturbances are temporary and the land is usually reclaimed back to the original productivity or, if well planned, to an enhanced land use (e.g. wildlife/fish habitat, off-road vehicle park).

Air Quality Impacts

Greenhouse gas emissions

Due to the volumes of aggregate resources being transported on a daily basis, mostly by trucks, which emit greenhouse gases, a strategy to prevent larger emission rates would be to ensure that haul distances are minimized. This entails resource inventory, followed by the planning of rural and urban development that maintains access to the resources until they are depleted, and designing road networks to incorporate the market-supply parameters. Chapter 5 details the environmental and economic costs of sterilizing a near market aggregate source.

Particulate pollution

Extraction equipment and haul trucks are sources of particulate matter through the combustion of diesel fuel. There have been health hazards linked to diesel particulate matter (State and Territorial Air Pollution Program Administrators, 2000). Exposed

subsoil, crushing activities, and truck traffic all have dust creating-potential. Opponents to mining have used the argument that there may be a hazard associated with silica-rich dust from pit activities to prevent approvals of pit development.

Noise pollution

The noise of crushers, excavating equipment, and trucks hauling the material from the pit, and especially backup alarms on mobile equipment, are annoyances that commonly generate public opposition.

Water Resources Versus Aggregate Resources

Surface water (excluding the polar ice caps) accounts for 40 % of the world's freshwater supply. Any additional demand will be directed to the larger reserves in groundwater sources (Pielou, 1998). The global demand on water resources has dramatically increased due to domestic, agriculture, and industry uses. Along with this rise in demand, freshwater systems have been altered through the draining of wetlands, dam construction, irrigation, and transferring water between natural drainage basins. This has changed the hydrological cycle within many of the world's water basins (Pielou, 1998).

North Americans draw 20% of their water needs directly from aquifers (Pielou, 1998). These underground sources also maintain surface water flows by capturing large amounts of rainwater and surface water, which in turn are recycled back to the surface (Sophocleous, 2002). In Canada, surface water is still the largest supply source; however, groundwater is becoming a necessary additional source. Groundwater was the source for in excess of 20% of the Canadian population in 1993, and 27% in Alberta (Environment Canada, 1999).

Aquifers are commonly formed by sand and gravel deposits, which are also valued as aggregate resources. No documentation could be found regarding the potential impact to water resources from the extraction of sand and gravel deposits in Canada, 65% of which comes from sand and gravel deposits. Environmental concerns addressed by scientific research relate to water primarily pertain to extraction activities from fish-bearing river channels. Nevertheless, a potential risk of aquifer contamination from extraction operations exists.

It is well documented that potable water is essential to the health and economy of a nation (Bridge and Husain, 2000). Public awareness of the value of these water resources has been long established through the educational system. On the other hand, aggregate resources have not received similar recognition despite society's heavy dependence and large consumption of these resources. As a result, many proposed sand and gravel extraction operations are not being approved or are restricted by wide buffer zones imposed to protect water resources. As society increases the measures to protect water resources through such initiatives, such as Alberta's "*Water for life: Alberta's strategy for sustainability*" (Alberta Environment, 2003), tighter regulations will likely be imposed on the aggregate resource sector, without consideration of the implications of the loss of aggregate resources.

Introducing an extraction operation into an aquifer may impact the water resource by changing the flow characteristics of the medium or increasing the contamination potential. Many toxic chemicals are used in the mining equipment, such as hydraulic fluids, fuels, and oils, and in the processing of aggregate, asphalt oil. The risk of groundwater contamination by these chemicals or others introduced through surface runoff is increased when protective layers of topsoil and clay are stripped off underlying permeable sand and gravel deposits. The layer of topsoil is an organic medium that breaks down many toxic chemicals, and the clay of glacial till layers (which cover many Albertan aggregate deposits) acts like an impervious shield to the aquifers. These layers are analogous to skin on a human that prevents infection until the skin is damaged. Gravel extraction becomes the wound and the risk of infection comes with the chemicals introduced to the site through a number of sources.

By conducting a detailed environmental impact assessment, it may be possible to implement the appropriate operating procedures and extract a portion of the aggregate resources without compromising water resources. The aggregate resource sector will have to respond to this situation by highlighting, to the regulators and public, the importance of taking into consideration the value of the aggregate resources. The sector will also have to develop measures that minimize the impact on water resources.

Social Considerations of Mineral Aggregate Production

The demand for aggregate resources by our society is increasing. Even with the recycling of concrete and asphalt, mineral aggregate will remain in high demand as development continues and infrastructure ages. Table 3 shows an 11% increase annual Canadian aggregate consumption between the years 1995 and 2001. In most cases, mineral aggregate extraction and production are activities that benefit all the members of society while affecting a relatively small number who are in close proximity to an extraction operation or haul route.

It is urban and rural development that creates the need as well as the opposition to the mining activity. Community members affected by the activities are seldom directly compensated. As a result, the "NIMBY" (Not In My Back Yard) perspective is a growing social phenomenon, which restricts or prevents access to and extraction of the most economical and environmentally friendly aggregate resources. As an example, due to the concerns of one resident, the recent approval for an aggregate resource mine in the Calgary area has cost the producer company $1 million in legal and consulting fees to justify why the approval should be allowed (ASGA, 2004). The Environmental Appeal Board, which is reviewing the case, appears not to be concerned about the environmental, economic, and social impacts that would be associated with the producer meeting the local demand from alternative sources. From this standpoint, the social aspect is being given priority over economics and environmental considerations; therefore, movement towards sustainable development is being lessened.

The aggregate resource sector has started to respond to community concerns by addressing and mitigating issues on an ongoing basis. In conjunction with this initiative, governing bodies (state to municipal level) are starting to recognize the importance of orderly development through the planning processes.

Proper governance (see Chapter 4) is necessary to guide planning processes that include consideration of the value of aggregate resources, for creating an "even playing field" for aggregate producers, and for compensating those members of society who are affected by extraction and hauling activities.

Summary and Conclusions

Globally, today's modern society relies heavily on aggregate resources, with over 60% of production being used in road network construction and maintenance. This reliance is not reflected in provincial and municipal planning processes, because land use/conservation zoning decisions are usually made without consideration of the aggregate resource potential. Therefore, the integrated resource management process, promoted by Agenda 21 as a sustainable development program, is missing an essential component in light of the consumption rates associated with the aggregate resources. As a result, significant economical, environmental, and social impacts, associated with this sector, will likely affect our ability to move towards sustainable development.

The true economic picture for aggregate resources is not accurately being captured due to shortfalls within the collection processes of production data. The Canadian aggregate production statistics, published by Statistics Canada, are suspected of inaccuracy, according to two AGS assessments. The inaccuracy of the published data has also been validated by a sector survey (Chapter 6, p. 102). In Alberta, production data capture is not required for private land operations and is not well monitored for public land activities. The situation may be a result of Alberta's legislation, which has transferred the ownership rights of these resources, from public control (government) to the landowner (see Chapter 4).

Although the Canadian production statistics are likely below actual production rates, the data quantify the reliance society has on these resources, which has significant economic implications. Comparisons between the provincial statistics indicate Alberta's cost for aggregate is escalating the fastest. This could be a result of Alberta's planning processes, which seldom factor in aggregate resource potential. Comparing average resource haul distances within each province, a factor not included in the data, would be another way of assessing the economic impact. The other aspect related to haul distance is an environmental impact through greenhouse gas emissions, which also translates to economic considerations via programs such as the Greenhouse Gas Emission Trading Pilot (GERT, 1998).

Although resource mining is a temporary activity, significant environmental factors are associated with the activity through land disturbances, compromising other

resource values, especially water resources. However, the loss of those resource values has to be weighed against the effects of increased resource hauling distances, if alternative sources are further from the market place. In addition, enhanced land uses or conservation areas can result from well-planned mining operations.

Finally, the social considerations become paramount as residential development and the mining activities encroach upon one another. Although society demands affordable housing and an efficient, well maintained road network, the NIMBY aspect will always pressure the mining sector to more expensive and environmentally detrimental operations. Until planning processes incorporate aggregate resource potentials, the NIMBY scenario will escalate as Alberta continues to develop.

To date, aggregate resource extraction activity's relationship to the economic, environmental, and social aspects, has been largely overlooked. Therefore, the sector becomes an area of opportunity for improved resource accounting, a necessity of implementing a totally functional integrated resource program, as called for by Agenda 21.

Chapter 3 Mineral Aggregate Resources of Alberta

Production History

The settlement of Alberta was enhanced by the construction of the railway in 1883. In 1881, Alberta was home to approximately 1000 non-native settlers. By 1891, the population had risen to 17,500 and through a massive promotional campaign conducted in Europe, the population expanded to over a half-million people by 1921 (Alberta Government, 2004d). The construction of the railway may have created the first major demand for aggregate resources, then came the development of road networks for settlements and farms. The use of aggregate resources by farmers to upgrade their roads, created a tradition that set the stage for establishing the rights to the resources, in Alberta, to this day.

Likely all of the aggregate resources used for early settlement came from surface sand and gravel exposures, and records of the early production rates were likely not captured from resources being extracted from homestead lands. Statistics Canada have been collecting resource production since 1886 (Statistics Canada, 2000). However, aggregate resources were not specifically categorized until the late 1940s or early 1950s and there has always been a question of the accuracy of aggregate production rates due to data collection procedures and the sector's reluctance to release production figures. The 2001 survey indicates Alberta's 40+ million tonne annual consumption for a population of 3 million, still primarily comes from sand and gravel sources (Statistics Canada, 2003).

Alberta's consumption of aggregate resources from 1950-2000 has been estimated at 2.2 billion tonnes, and from 2000-2050 will amount to 5.0 billion tonnes (Edwards, 2001). Past production has depleted much of the surficial sand and gravel deposits and a large amount of reserves have been zoned to prevent resource extraction.

Alberta's Surficial Geology

Alberta's mineral aggregate sources fall into four categories: bedrock, preglacial sand and gravel deposits, glaciofluvial deposits, and recent alluvial deposits (Figure 2). In Alberta, bedrock only contributes 1% towards Alberta's aggregate resource production (2001) as most bedrock is either covered with glacial deposits or is in close proximity to

more economical extractable sand and gravel deposits. The trend to produce aggregate from bedrock is increasing as sand and gravel sources dwindle through depletion and sterlization (loss of access to extract the resource) by conflicting land uses.

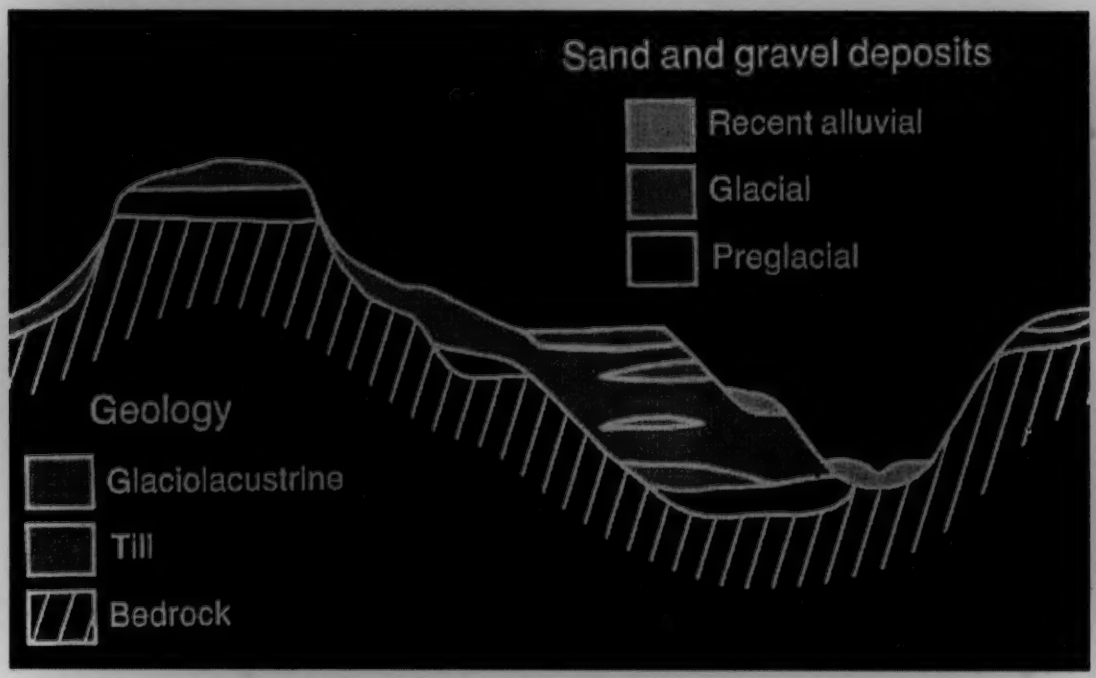

Figure 2: Cross Section Showing the Categories of Aggregate Sources (Edwards, 1983)

Bedrock

Due to the extra costs involved in mining bedrock compared to sand and gravel extraction of these sources only become viable when extracted as a byproduct of quarry operations within the Rocky Mountains (southwest Alberta), and from bedrock exposed by the oil sands operations in the northeast part of the Province where aggregate resources are in short supply. Only one operation in Alberta (Grande Prairie) is using bedrock solely as an aggregate source, and this operation started as a sand and gravel extraction site but discovered the underlying bedrock could be economically extracted and used for concrete material.

Preglacial deposits

The Alberta Geological Survey (AGS) has inventoried 203 probable pre-glacial deposits in Alberta, which vary in age of deposition from between about 50 million years ago to 25,000 years ago (Edwards, 2000). The rivers associated with deposition were draining eastwards and northeastwards through a bedrock landscape. Through continental uplift many deposits were elevated and occur on topographic highs. Cyprus Hills, Swan Hills, and the southern foothills are locations where these deposits can be found. Progressively younger deposits accumulated at lower elevations. Edwards et al. (1996) classified the preglacial deposits into four categories based on age (Figure 3).

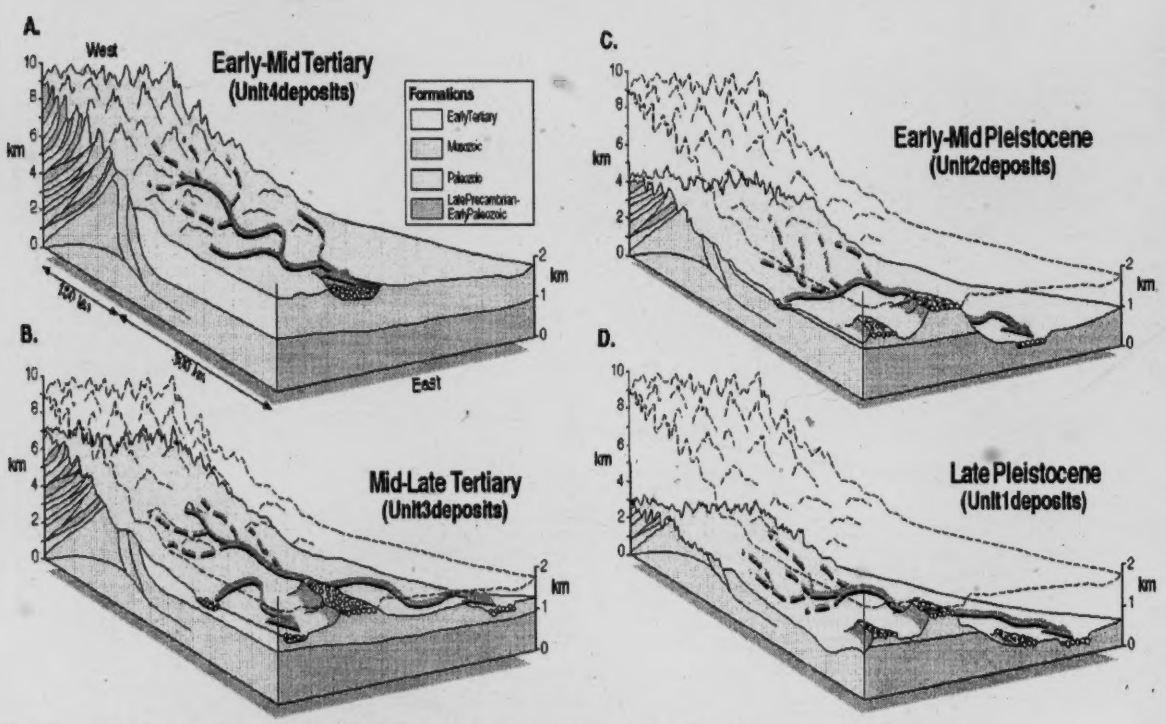

Figure 3: Preglacial Depositional Phases (Edwards and Scafe, 1996)

Unit 4 (Figure 4) formed in the early-mid Tertiary era and is located on the highest hills on the plains. The elevated gravel deposits of Cypress Hills, western Del Bonita Uplands, the eastern foothills and the Swan Hills are examples of this category (Figure 7).

Figure 4: Unit 4 Preglacial Gravel, Cyprus Hills

Unit 3 deposits relate to late Tertiary gravel deposits on hilltops and ridgetops on the plains. These include the deposits capping Wintering Hills, Whitecourt Mountain, Halverson Ridge, and the Pelican Mountains (Figure 7).

Unit 2 (Figure 5) deposits were formed during the Quaternary era at the plains elevation. These deposits are located near Grimshaw, Entwistle, Lacombe, and Cluny (Figure 7).

Figure 5: Unit 2 Preglacial Deposit, Avenir (northeast Alberta)

Unit 1 deposits (Figure 6) formed in the Quaternary. They are the most common of the preglacial deposits, and are found as buried channels. By dating the fossils within these deposits they range from 22,000 to 40,000 years ago (Edwards et al., 1996). Villeneuve, Simonette, and Watino are examples of the Unit 1 formation (Figure 7).

Figure 6: Unit 1 Preglacial Deposit, Watino (northwest Alberta)

The preglacial gravels of Unit 1 have been deposited by an east, north-easterly drainage flow, similar to today's river systems, over an eroded buried landscape of gently westerly dipping Cretaceous and Tertiary bedrock sediments. Variations in the drainage patterns were the Red Deer River, which had a course north of its present position that is now occupied by the Battle River in places. The Milk River likely flowed into the South Saskatchewan River ending up in the Hudson Bay. The magnitude of erosion, experienced prior to the glaciations, is marked by the valley depths and widths.

The buried river channels of Saskatchewan, which have greater relief than Alberta's, have gently dipping slopes from four to ten miles wide. The channels are also deeper in Saskatchewan with up to 1000 feet of drift (Christiansen, 1967). The depths and sizes of the boulders of the preglacial gravels that have been deposited within these buried channels also give a perspective on the magnitude of water flow and erosion.

The preglacial deposits make excellent aggregate sources, due to the quality of gravel (hard, resistant cobbles) within the deposits. To be economically viable they must be relatively near the surface. The Villeneuve deposit, a major aggregate source for Edmonton, is a preglacial channel buried under 13 metres of till and glacial lake sediments.

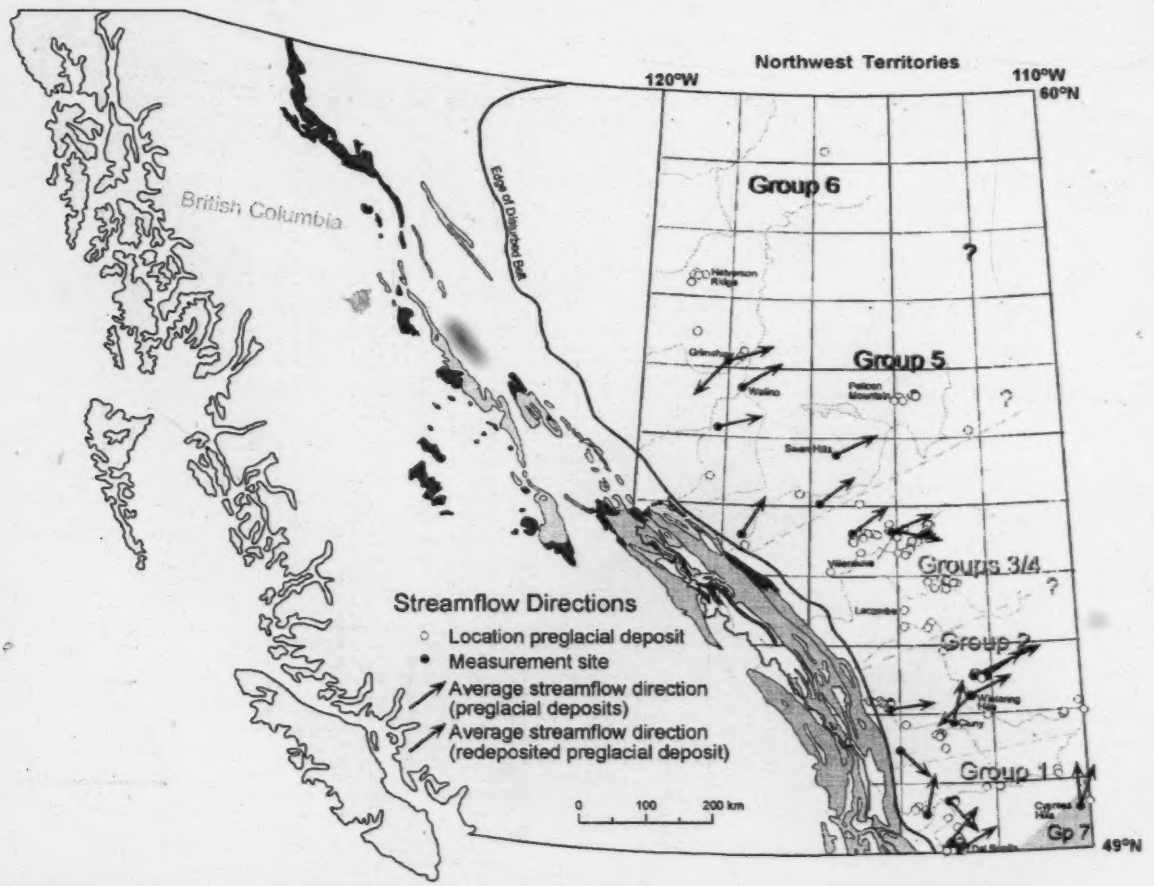

Figure 7: Preglacial Groupings by Composition Related to Source Locations (Edwards, 2000)

The AGS has categorized seven groups of preglacial deposits based on the composition of the stones within the deposits (Fig. 7). All preglacial deposits are characterized by their coarse sediments originating from the sandstone and quartzite formations in the Omenica Terrane in British Columbia or the Rocky Mountains. Correlation of these source rocks relates to a predominant northeast drainage pattern at the time of formation (Edwards, 2000).

Glaciofluvial Deposits

Geological evidence indicates Alberta has been subjected to massive depositional environment between 14,000 and 11, 000 ybp (Dyke and Savelle, 1999). The Laurentide Ice Sheet advanced and retreated re-depositing large amounts of material. Meltwater

channels are remnant indicators of high flow rates over a limited time period during the melt.

Recent research shows many global climate fluctuations have occurred. These fluctuations may have affected the depositional environment in Alberta and the most recognized reconstruction by Dyke and Savelle (1999) may be subject to variations. Correlating these new climatic data during the post-Pliocene (1.8 to 1.6 million years before present) to AGS Quaternary reports may lead to the discovery of new aggregate resources.

Associated with the receding Laurentide Ice Sheet are a number of different types of deposits including kames, kame terraces, kame deltas, eskers, outwash plains, valley trains, meltwater channels, and crevasse fillings. These deposits all have varying amounts of clay, silt, sand, and gravel.

Kames are moundlike hills of poorly sorted drift, mostly sand and gravel, deposited at or near the terminus of a glacier. A kame may be produced either as a delta of a meltwater stream or as an accumulation of debris let down onto the ground surface by the melting glacier. A group of closely associated kames is called a kame field, or kame complex, and may be interspersed with kettles or kettle lakes.

Meltwater that escapes to the margin of a glacier will often deposit part of its load between the glacier and the valley wall. When the glacier retreats, the former stream bed is left perched above the deglaciated valley floor. This distinctive landform is termed a terrace, specifically, a kame terrace. Kame terraces are distinctive because of their flat surfaces (compared to the rolling moraines often found above them), steep slope into the valley, and composition of stream gravel rather than till.

Eskers probably mark the sites of subglacial streams and rivers. The gravel is sometimes heaped 12 to 24 m (40 to 80 ft) in height; and the length of an esker may run from 1.6 to 32 km (1 to 20 mi).

The outwash plains generally provide the best aggregate sources of the glaciofluvial deposits because of their size and composition. Figure 8 provides an illustration of the deposit types.

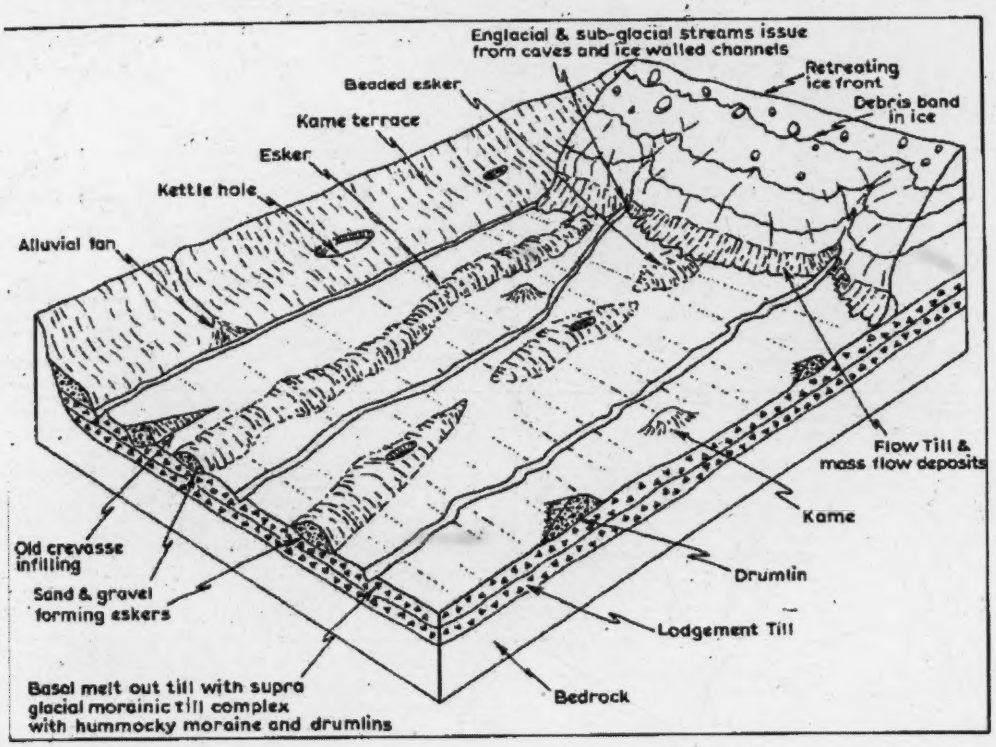

Figure 8: Glaciolfluvial Deposits (Strahler 1960, cited by Williams Jr., 1986)

Fluvial Deposits

Isostatic rebound of the land surface after the recession of the ice sheet played an important role in the evolution of today's watershed configuration. Many sand and gravel deposits have been left perched at higher elevations as the rivers shifted and cut into the landscape. The present day watercourses are reworking and building new deposits through their regular flow cycles and irregular flood events (Figure 9).

Figure 9: Fluvial Deposits (Beaver River, Alberta)

Distribution of Aggregate Deposits in Alberta

Alberta's geological history has given the province a wealth of aggregate resources. Most aggregate deposits worked have been surficial deposits, which were located without the need of geological analysis. Due to transportation costs, most of the sources used are those closest to the areas of need. Alberta's wealth has likely been accentuated by the availability of aggregate resources. However, this availability is becoming threatened by the number of rural residences or industrial developments occurring near or over aggregate potential areas. The Alberta Sand and Gravel Association (ASGA, 1994) claims that the resources are diminishing faster than replacement sources are being approved. Some areas of the province are experiencing a heavy demand with a limited supply of aggregate resources, such as the oilsands development in the northeast portion.

There is a growing need to locate new economical aggregate resources, which will not conflict with current land uses. To predict the occurrence of unknown sand and gravel deposits and to understand the environmental impact of the extraction of a deposit, a detailed understanding of the depositional history of Alberta is required. Depositional history of sand and gravel is associated to the drainage patterns, present and ancient. To understand the ancient drainage patterns, glacial advances and retreats can be

reconstructed. Knowledge of the climatic variations may aid in the reconstruction of glacial movement and their associated drainage deposition patterns. Detailed sedimentation mapping of sand and gravel deposits as they are extracted could lead to a better understanding of the historical depositional environments. Therefore, use of geological and geophysical assessments will likely increase, as the aggregate resource sector seeks new sources.

Alberta Geological Survey Data Used to Locate Aggregate Resources

The Alberta Geological Survey (AGS) has been conducting geological mapping of the province since 1921 "*to provide geoscience information and expertise needed by government, industry and the public for earth-resources stewardship and sustainable development in Alberta*" (AGS, 2004). The Survey has conducted and is conducting geological assessments that are beneficial to identify the aggregate resources of Alberta.

AGS Surficial Mapping

The AGS in conjunction with the Geological Survey of Canada has conducted systematic surficial geological mapping for approximately 2/3 of the province (Figure 10). The mapping indicates predominantly the surface material (top few metres) in the description of the materials' genesis and can be an indicator used for identifying potential aggregate sources.

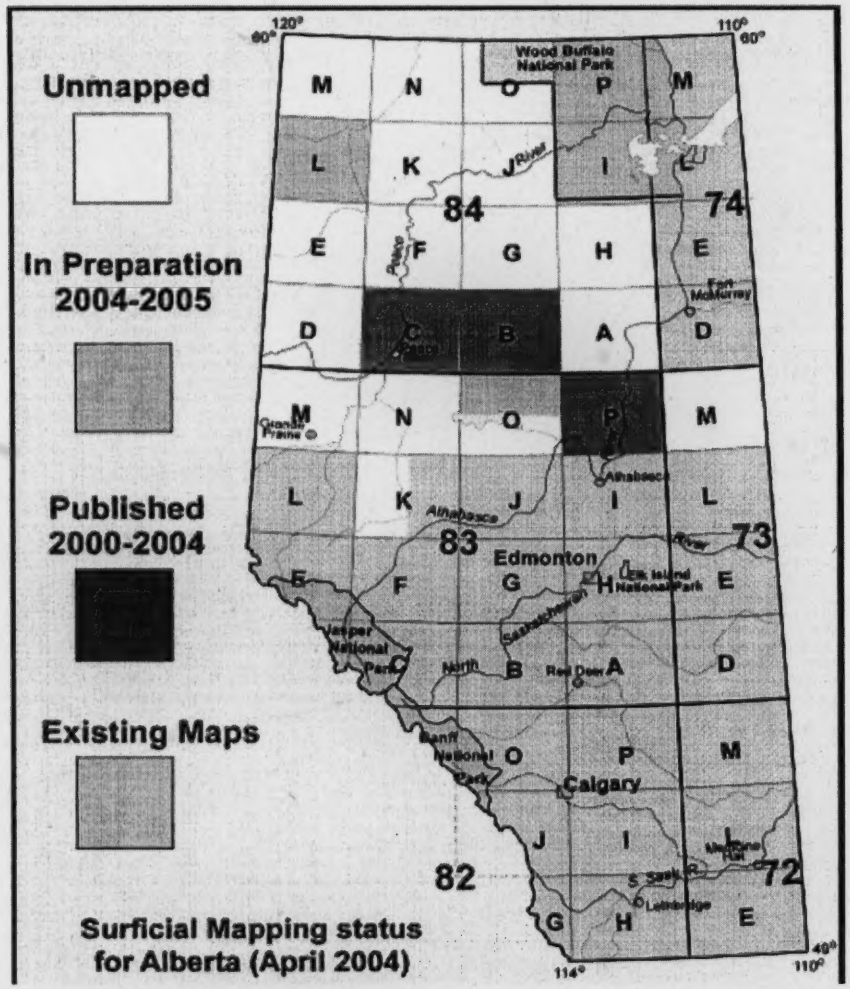

Figure 10 Surficial Mapping Status of Alberta in 2004. Courtesy of the Alberta Geological Survey; Paulen, 2004.

AGS Aggregate Resource Mapping

The AGS has conducted an aggregate resource inventory for the province between 1976 and 1990. The program appeared to be initiated by the 1976 Villeneuve aggregate extraction study, which recommended a provincial aggregate resource inventory (Shelley, 1977, p. 269). Under the program, thirty percent of the province has been covered at a scale of 1:250,000. However, only 18% of the province has been inventoried at a "Level 3" (1:50,000) or which maybe detailed enough to capture the location of the aggregate resources for land/resource management purposes (Figure 11). The *Aggregate Resource Inventory* maps were surveys that focused on evaluating the

deposits sediments, and included potential aggregate reserves through various subsurface data (e.g. water well logs, survey drill logs).

The AGS classifies aggregate identification on maps with five levels of confidence (Level 1-5 respectively, Table 5):

Table 5: Mapping detail of AGS data

Level	General Work Description	Scale
1	Detailed evaluation of a deposit	Report & Plan
2	Mapping of a single deposit	Report & Plan
3	Detailed regional mapping: many sources of data and a field assessment component	1:50,000 Map and/or Report
4	Reconnaissance regional mapping: air photo interpretation, compilation of different data sets, & field assessment	1:250,000 Map and/or Report
5	Reconnaissance regional mapping: air photo interpretation, compilation of different data sets, no field assessment	1:250,000

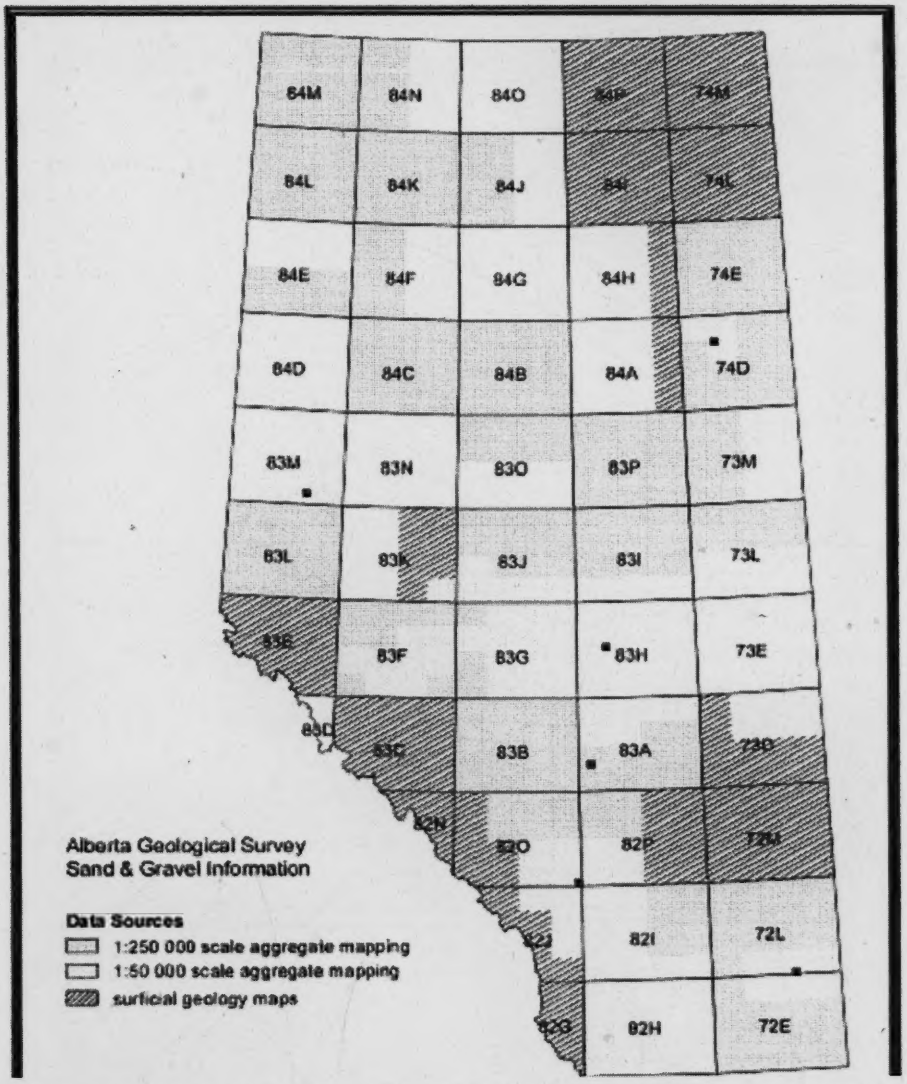

Figure 11: Available AGS Aggregate Resource Data (Courtesy of the AGS; Budney, 2004)

The majority of the AGS detailed aggregate mapping is in excess of 20 years old. The reconnaissance regional mapping provided a faster area coverage rate, the preference of the land management agency at that time.

Resource estimates are typically associated with Levels 1, 2 and 3 AGS aggregate information. Level 4 and 5 in rare instances do have resource information where information provided from a possible third party (i.e. Alberta Transportation testing data).

Aggregate deposits mapped a number of years ago may have been partially or fully extracted, therefore the reserve information would no longer be valid.

AGS Stratigraphic Reports

In addition to the surficial and aggregate resource mapping, the AGS has generated a number of reports focusing on the glacial deposits. The majority of Alberta's aggregate resource production comes from sand and gravel deposits, not associated with present water drainage systems (rivers). The following AGS reports have been reviewed to understand the correlation of sand and gravel deposition within the glacial stratigraphic sequencing of Alberta.

Edmonton Area

According to Andriashek's (1988) *Quaternary Stratigraphy of the Edmonton Map Area,* the Cretaceous bedrock and Tertiary sediments have been draped by a Quaternary depositional sequence consisting of interbedded fluvial and till layers. The report has the layers categorized into tills and stratified sediments (Table 6).

The report encompasses 9200 square kilometres and has been evaluated through 84 exploratory dry-augered holes, outcrops along the North Saskatchewan River, water well logs, previous geological reports, and oil company structure testhole logs. In excess of 2000 drift data points capture the surface of each drift unit. The thickness of the drift varies from 10 m to over 70 m. Manipulation of such data to find shallow course-grained sediments or low till to course-grained sediment depth ratios (one to one or less) maybe a worthwhile exercise to explore for economical gravel sources.

The cross sections of the report illustrate the undulating bedrock topography, which may have controlled drift deposition. As an example, the thickest accumulations of glacial material collected in the valleys craved within the bedrock.

Sand River Area

Alberta Research Council's Bulletin No. 57, authored by Andriashek and Fenton (1989), describes the Quaternary stratigraphy and surficial geology of the Sand River area. The report summarizes the geologic events by periods as shown in Table 6.

Era	Period	Environment	Edmonton – Andriashek (1988)	Sand River – Andriashek & Fenton (1989)	Vermilion – Mougeot (1991)	Washington – Crandell (1971)
Quaternary	Holocene	Warm - Erosional	Portglacial and recent stratified sediments			Winthrop Creek Glaciation
						Hypsithermal interval
	Pleistocene	Glacial retreat – depositional & erosional	Glacial Lake Edmonton Stratified Sediments	Post Glacial Stratified Deposits		
	Late Wisconsian	Glaciated – erosional and depositional	Cooking Lake Till	Cold Lake Glaciation Grand Centre Formation – Vilna Member Kehiwin Lake " Reita Lake ". Hilda Lake "	Lostwood Glaciation Diamicton Units F E D	Fraser Glaciation
	Mid-Wisconsian	Glacial advance - depositional	Elk Island Stratified Sediments	Sand River Formation	Stratified Unit D	Olympia Interglaciation
		Warm - erosional		Oxidation of Marie Creek and Bonnyville Formations	Oxidation of Diamicton Unit C	
		Retreat - depositional	Elk Island Stratified Sediments	Sand River Formation	Stratified Unit D	
		Glaciated - erosional and depositional	Chipman Till (carbonate rich)	Ardmore Glaciation Marie Creek Formation – Unit 2 (carbonate Unit 1 rich)	Ardmore Glaciation Diamicton Unit C (carbonate rich)	Salmon Springs Glaciation
		Advance - depositional		Ethel Lake Formation	Stratified Unit C	Puyallup Interglaciation
	Early Wisconsian	Warm - erosional		Oxidation of the Bonnyville Formation	Oxidation of Diamicton Unit B	
	Pre-Wisconsian	Retreat - depositional		Ethel Lake Formation	Stratified Unit C	
		Glaciated - erosional and depositional		Fort Kent Glaciation Bonnyville Formation – Unit 2 Unit 1	Fort Kent Glaciation Diamicton Unit B	Stuck Glaciation
		Advance - depositional	Ministik Lake Stratified Sediments	Muriel Lake Formation	Stratified Unit B	Alderton Interglaciation
		Warm - erosional		Oxidation of Bronson Lake Formation		
		Retreat - depositional	Ministik Lake Stratified Sediments	Muriel Lake Formation	Stratified Unit B	
	Pre-Wisconsian	Glaciation - erosional and depositional	Lamont Till	Cherry Grove Glaciation Bronson Lake Formation	Cherry Grove Glaciation Diamicton Unit A	Orting Glaciation
		Advance - depositional	Empress Formation	Empress Formation – Unit 3 Unit 2	Stratified Unit A	

Era	Period	Environment	Edmonton - Andriashek	Sand River – Andriashek & Fenton	Vermilion - Mougeot	Washington - Cordilleran
Tertiary		Erosional		Empress Formation – Unit 1 (no Shield rx)	Stratified Unit A (no Shield rx)	
Cretaceous		Marine	Paskapoo Formation			
		Continental depositional	Wapiti Formation			
		Marginal marine to Continental depositional	Horseshoe Canyon Formation			
		Marine	Bearpaw Formation			
		Transition - Marine to Continental depositional	Belly River Formation	Belly River Formation	Belly River Formation	
		Marine		Lee Park Formation	Lee Park Formation	

Table 6: Correlation of Mapping Surveys

This report covers 14,000 km^2 incorporating four sources of subsurface data that include 900 test holes. On the basis of geophysical log response, composition, texture and stratigraphic position, eight glacial and nonglacial formations are recognized (See Table 6).

Vermilion Area

Mougeot's thesis, *Quaternary Geology of the Vermilion-East Area, Alberta* (1991), covers the area directly south of Sand River map sheet. The study describes two Cretaceous formations, the Lea Park and the Belly River Formations, which are covered by interbedded stratified and unstratified layers . The report covers 7500 square kilometres. The area was evaluated through air photography followed by ground truthing. Out of an estimated 700 logs reviewed, 268 logs were used from well-water drilling, coal studies and other subsurface data. A drilling program from 1978 to 1981 bore 57 holes within the Vermilion map sheet of which 35 holes "*yielded reliable data deemed sufficient to interpret Quaternary stratigraphy*" (Mougeot, 1991, p.8). Seven drill holes specific to testing the stratigraphic interpretations along with electrical-resistivity logs and sidewall sampling were carried out in 1981 (Mougeot, 1991). Of the 21 map units described in this report, including the "Fluvial Sediment Undivided", only the "Glaciofluvial Deposits" and the "Ice-Contact Glaciofluvial Deposits" are referenced as suitable for aggregate sources.

Mougeot's thesis describes the "deglaciation history" as four distinguishable events (Table 6).

Central Alberta Area

Using the data collected by all previous surficial geology mappers (including Andriashek, Bayrock, Boydell, Edwards, Ellwood, Fenton, Fox, Gravenor, Kathol, McPherson, Mougeot, Peterson, Reimchen, Richard, Stalker, St. Onge), Irina Shetsen produced the map entitled "*Quaternary Geology – Central Alberta*" (1990). Shetsen's map shows how surficial geology mapping, alone, does not capture all the aggregate resource potential areas. The Calahoo/Villeneuve aggregate resource deposit, a major source of aggregate for Edmonton, is indicated as an area of fine sediment (sand and silt) deposited in a lacustrine environment. A separate report of subsurface hydrogeological

data for this area documents the existence of a thick layer of course sediments under the lacustrine deposit. The AGS's Aggregate Resources Map, a derivative product from a combination of the surficial and the hydrogeology mapping, along with a number of other sources, does outline the "Villennueve deposit".

Correlation of Northern Studies to Alberta's Geological History

The Wollaston Peninsula of Victoria Island of the Canadian Arctic provides an excellent model for landforms associated with glacial retreat. Numerous marginal positions are well preserved, giving a detailed picture of glacial retreat at a decadal or better resolution. Dyke & Savelle's (1999) paper suggests the northern studies can be used to strengthen the accuracy of formulating depositional interpretations of other regions.

Mapping Project

Initially as part of this research, a mapping project to include the areas assessed under "Stratigraphic Geological Surveys" (p. 44), was proposed to assess the correlation of the pit locations to the geological information. It was planned to obtain data sets from the AGS (surficial geology and aggregate resource inventory), Alberta Environment (pit locations on private land), and Sustainable Resource Development (pit locations on public land). The exercise became very complex due to the different system formats used by the different agencies, but was resolved by incorporating the mapping exercise into an assessment of aggregate resource information being conducted by SRD. The only difference in this mapping project, is that an area of Alberta was chosen where the surficial geology, was conducted under the latest data collecting methods used by the AGS. Therefore, instead of central Alberta being analyzed, the National Topographic System (NTS) map area 84C (Peace River, Alberta, Figure 12) was assessed.

The mapping project has been conducted by a consultant of Hemmera Envirochem. Bill Gowdy of Hemmera imported data sets from a number of sources to produce two maps of NTS map sheet 84 C. The aggregate potential areas taken from the surficial mapping (including the deposit genesis of eolian, fluvial, glacial fluvial, ice contact deposits, and preglacial) and the aggregate resource potential areas mapped under the Aggregate Resources program were directly imported into Hemmera's Geographical

Information System (GIS) in an ArcInfo E00 format. The pit approval information that came from SRD, Environment, and Transportation all had to be converted from legal land descriptions into coordinate points, to be included into the GIS.

The following information shows the analysis of the compilation maps, which are included in a report submitted to SRD by Bill Gowdy, P.Geol. of Hemmera Envirochem (2004).

Firstly, map sheet 84 C contains a total of 6% of the 1,369,575 ha that has aggregate resource potential according to the Aggregate Resource mapping program (Table 7).

Table 7: Aggregate Resource Inventory Area Coverage of NTS Map Sheet 84C (Gowdy, 2004)

AGS Aggregate Mapping Level	Potential Aggregate Resource Area (ha)	% Map Sheet NTS 84C
1		0.000%
2		0.000%
3	59,683	4.358%
4	10,174	0.743%
5	16,922	1.236%
Totals	**86,779**	**6.336%**

In comparison, the surficial mapping indicates 14% of the map sheet area has aggregate resource potential (Table 8).

Table 8: Surficial Mapping Unit Area Coverage of NTS Map Sheet 84C (Gowdy, 2004)

AGS Surficial Mapping Deposit Type (Genesis associated with sand and gravel)	Potential Aggregate Resource Area (ha)	% Map Sheet NTS 84C
Eolian	30,216.5	2.206%
Fluvial	62,940.6	4.596%
Glacial Fluvial	95,605.4	6.981%
Ice Contact Deposit	7,338.5	0.536%
Pre Glacial	190.4	0.014%
Totals	**196,291.4**	**14.332%**

Of the aggregate resource potential areas that are mapped by each method only a small percentage of the potential areas are identical. Table 9 and Figure 12 show the correlation of deposit genesis of surficial mapping with that of the aggregate resource mapping. Only the "pre glacial" deposits have good correlation.

Table 9: Correlation Between Surficial Geology and Aggregate Resource Data (Gowdy, 2004).

Surficial Mapping Deposit Type (Units associated with sand and gravel)	Aggregate Resource Potential Area (ha)	Overlap Area – Surficial In Mapped Aggregate Resource Potential Polygons (ha)	% Overlap	Area Not Overlapping (ha)
Eolian	30,216.5	680.4	2.25%	29,536
Fluvial	62,940.6	15,740.6	25.01%	47,200
Glacial Fluvial	95,605.4	6,618.4	6.92%	88,987
Ice Contact Deposit	7,338.5	596.0	8.12%	6,743
Pre Glacial	190.4	190.4	100.00%	-
Totals	**196,291.4**	**23,825.8 ha**		**172,466 ha**

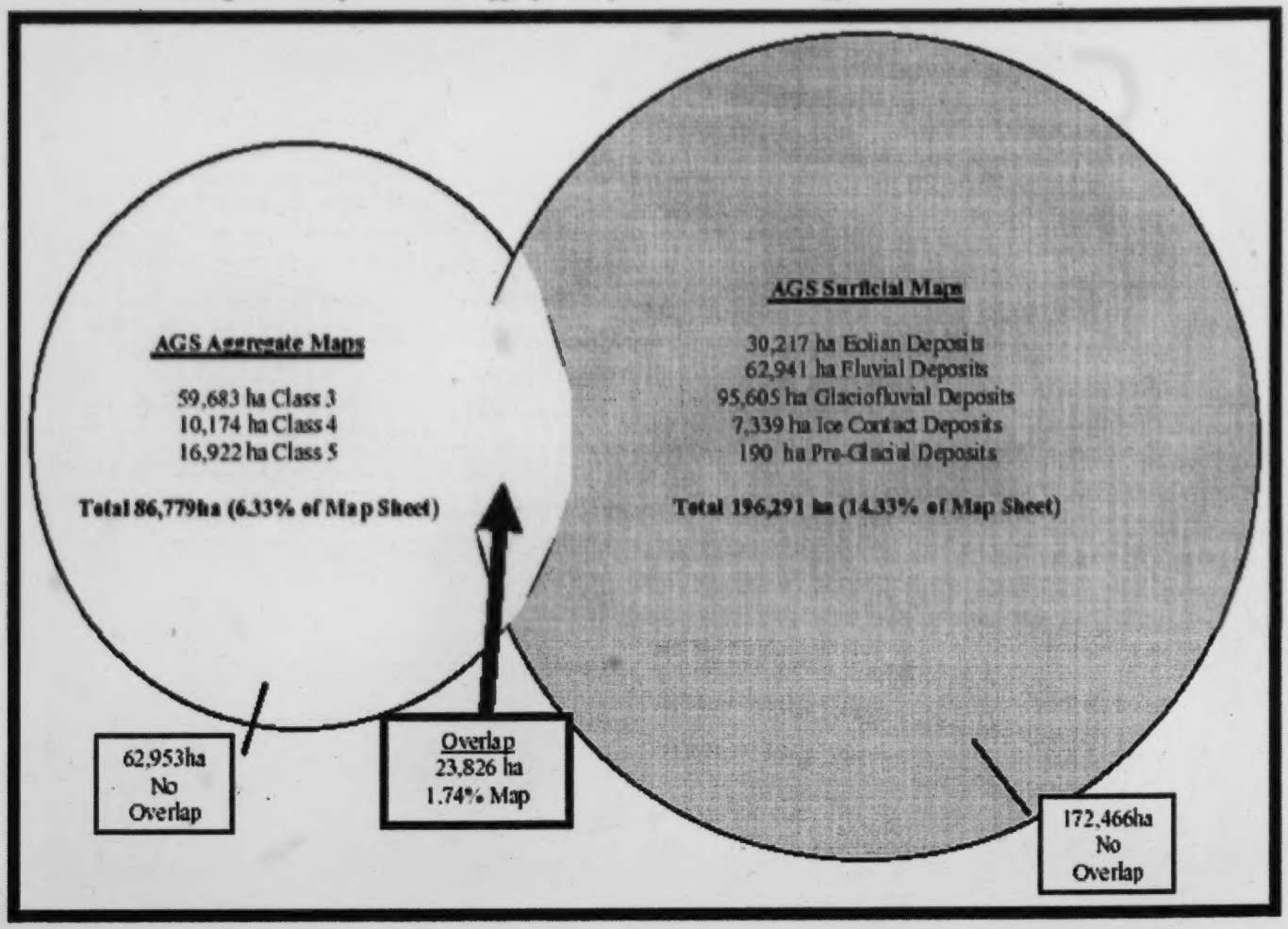

Figure 12: Comparison Between AGS Aggregate Resources Maps and Surficial Geology Aggregate Deposits (Gowdy, 2004).

There is a better correlation between pit locations and the aggregate resource mapping method, in comparison to the surficial mapped aggregate potential areas. Tables 10, 11, and 12 show the correlations between three different government agencies pit location data related to aggregate potential areas of the aggregate resource mapping program.

Table 10: Correlation Between Extraction Operations and Aggregate Potential Areas from SRD data (Gowdy, 2004).

Number of Public Land Pit Approvals	AGS Aggregate Resource Mapping Level	% In Aggregate Potential Polygons
258	Outside of Mapped Aggregate	65.32%
71	3	17.97%
15	4	3.80%
51	5	12.91%
395		

Table 11: Correlation Between Transportation Extraction Sites and Aggregate Resource Potential Areas from Alberta Transportation data (Gowdy, 2004).

Number of Transportation pit approvals	AGS Aggregate Mapping Level	% In Aggregate Potential Polygons
84	Outside of Mapped Aggregate	43.52%
74	3	38.34%
11	4	5.70%
24	5	12.44%
193		

Table 12: Correlation Between EPEA Approvals and Aggregate Resource Potential Areas from Alberta Environment data (Gowdy, 2004).

Number of Pit Approvals (EPEA)	AGS Aggregate Mapping Level	% In Aggregate Maps
5	Outside of Mapped Aggregate	17.24%
21	3	72.41%
2	4	6.90%
1	5	3.45%
29		

The reason for the lower correlation on public land, is the data includes aggregate resource exploration locations, which in many cases covers land that are not associated with aggregate resource deposits.

Aggregate Resource Geological Data Used Towards Sustainable Development

"*Alberta's Commitment to Sustainable Resource and Environmental Management*" (Alberta Government, 1999a) is being implemented through the Integrated Resource Management (IRM) process, a sustainable development process promoted by Agenda 21. Alberta Environment is using the IRM process "*to develop regional strategies as the bridge between provincial policy and local or project planning, and sharing ideas and information on IRM projects*" (Alberta Government, 2001-2004). The AGS has supplied the geological information to this process, which outlines mineral resource potential. Data sets for the *Northern East Slopes Sustainable Resource and Environmental Management Strategy* and the *Southern Alberta Sustainability Strategy* have been integrated into the GIS data capture. The IRM is an opportunity to include the aggregate resource potential areas (only recorded on public land), because the regular land use approval process seldom addresses these potential areas. As a result, some resource potential areas are developed upon or given land use/conservation designations that prohibit resource extraction. To prevent this from happening, resource information prior to development and land use/conservation planning is essential. However, the aggregate resource information that is being used in the IRM process is outdated and

incomplete in both strategy areas. Therefore, full resource development may not be achieved, impeding moving in the direction towards sustainable development.

Further, the AGS is contemplating discontinuing the aggregate resource mapping function as the financial support, that was received for the program from Sustainable Resource Development, was stopped in 1991. Since this time little new inventory information has been added. The AGS may deliver future aggregate resource potential based on the surficial mapping information. Based on the conclusions of the Hemmera report, this approach will be less effective.

Summary and Conclusions

It has been estimated that 5 billion tonnes of aggregate resources will be consumed in Alberta between 2000 and 2050. To be economically viable and environmentally acceptable (greenhouse gas emissions), the majority of the resources will be coming from preglacial sand and gravel deposits and deposits left behind by continental glaciation. In light of the Provincial strategy to protect the water resources, obtaining approval to extract from these sources will likely take an in-depth assessment of how such an activity will impact the groundwater resources. Also, access to extract many deposits is likely to be affected by the provincial and municipal planning processes, which do not routinely consider incorporating aggregate resource information.

Aggregate resource information for land use planning is not readily available in Alberta. A number of AGS stratigraphic reports were examined and compared to each other to determine potential aggregate resource areas. From this assessment of the geological data, it is evident the best aggregate resource potential information comes from the *Aggregate Resource Inventory Program* (ARIP) maps and reports. Of the 48% provincial coverage by the ARIP, only 18% is mapped at a level conducive to land use decisions and this information is out of date. In addition, the AGS is considering amalgamating the ARIP into the surficial geology-mapping program, due to the discontinued ARIP funding from Sustainable Resource Development and Transportation.

According to a recent study by Hemmera (Gowdy, 2004), the surficial mapping program is not as effective for identifying areas of aggregate resource potential. Hemmera's report (Tables 7 and 8) highlights the small percentage of surface area that

does equate to aggregate resource potential. This supports the need to determine these potential areas prior to other land use decisions that would prevent access to the aggregate resources. Even though there is a higher correlation between the geological data and the aggregate extraction sites by the ARIP mapping, in comparison to the surficial mapping, the ARIP mapping also misses potential areas (Tables 10, 11, and 12). The best correlation occurs between potential areas mapped on private land (Table 12). This is likely a result of aggregate resource exploration activity being included in the public land data. Many of the exploration programs are proposed through speculation and cover lands with no aggregate resources.

Collecting and quantifying resource data fits the integrated resource management (IRM) practice outlined by Agenda 21. The IRM process requires accurate, up-to-date inventory data. Therefore, any decision to lessen the capture of resource data diminishes the provincial government's commitment towards sustainable development.

Capturing of up-to-date aggregate inventory data, and the incorporation of the information to land use decisions, now becomes a heightened area of opportunity. The implementation of an effective aggregate resource inventory program is attainable through a shared, collaborative process, designed and committed to by all planning or resource management government and municipal agencies.

Chapter 4 Governance

The "integrated approach to the planning and management of land resources" outlined in Agenda 21 (1992) calls for the following "activities":

a) *developing supportive policies and policy instruments,*
b) *strengthening planning and management systems,*
c) *promoting application of appropriate tools for planning and management,*
d) *raising awareness,*
e) *promoting public participation,*
f) *strengthening information systems, and*
g) *strengthening regional cooperation and exchange of information on land resources* (United Nations Sustainable Development, 1992, Sections 10.6 to 10.12)

According to Agenda 21, each of these activities requires government involvement; therefore, governance can be considered a fourth cornerstone of sustainable development (Richards, 2002a).

In relation to the management of aggregate resources in Alberta, an examination of the evolution of relevant legislation provides insights for developing a sustainable development strategy for the aggregate resources sector.

History of Extraction Legislation and Policy in Alberta

Prior to the transfer of natural resources from the Federal government to the provinces on October 1, 1930, the *Dominion Lands Act* (1872-1931), excluded the rights to "all mines and minerals" from land sales. Mineral rights were obtained through a Crown lease, where the rent payable was a royalty, not to exceed 2 $^1/_2$ % on the net profits of the workings.

Limestone, granite, slate, marble, gypsum, marl, or any building stone including sand and gravel were regulated separately from the other minerals as "quarriable materials". The regulations for leasing and administering lands containing quarriable materials were first established under the *Dominion Lands Act* in May 13, 1910. Annual rental for the lease was $1/acre/year, and no royalties where payable. The term of the lease was 21 years with a maximum allowable size of 40 acres, and no one person could acquire more than one lease. The lessee had to commence active operations within one year of being notified by the Minister of the Interior. Notification was issued one year

after the issuance of the lease and the amount of material to be extracted was limited to 5 cubic yards/acre/year (ENR, 1977).

Clay was added as a quarriable material in 1912. Within two years, a lessee was required to erect a plant suitable for the manufacture of brick, but was subject to a maximum expenditure of $10,000 for the plant. After the second year the lessee was required to produce 100,000 bricks or their equivalent in some other form of clay products.

By 1913 the regulations allowed railway companies to acquire more than one "quarry location" lease strictly for railway construction and maintenance. In 1915 the multiple lease was also applicable to a city, town, municipality, or municipal district strictly for public works projects. Volcanic ash was added in 1926 to accommodate this use of the material in Saskatchewan.

Once the administration of natural resources was transferred to provincial control in 1930, the mineral rights were allocated under the *Provincial Land Act*. Under provincial administration the "Regulation for the Leasing of Lands Containing Limestone, Granite, Slate, Marble, Gypsum, Marl, Gravel, Sand, Clay, Volcanic Ash or any Building Stone" replaced the federal "quarriable material" rules on June 18, 1931. The only changes were that the quantity of material that could be quarried was not to exceed 10 cubic yards/acre/year, "sworn" returns were required every three months, and a royalty rate of 5 cents/cubic yard was levied. A lease was granted only where the Crown was the surface owner of the land.

By April 1, 1949, the regulation of mineral resources was enacted specifically through the *Mines and Minerals Act*. That was also when the Department of Lands and Mines was divided into the Department of Lands and Forests and the Department of Mines and Minerals, and separate provisions were purposely omitted from the *Mines and Minerals Act* applicable to quarrying leases. Of the quarriable materials, sand and gravel had been traditionally used by homesteaders throughout the Prairies in developing their farms; therefore, on private land, no authority was required to extract the resources. All other quarriable materials were leased as minerals, whether the Crown owned the surface or not. Sand and gravel lease administration was transferred to the Department of Lands and Forests in 1949 (ENR, 1977).

One of the first recorded problems resulting from the exception of sand and gravel from mineral rights, was a litigation between one company that had mineral rights and another party who had the surface rights to the same parcel of land. The landowner allowed a third party to remove the sand and gravel resources. Western Minerals, the title holder of "all mines and minerals", contested that the sand and gravel resources were inclusive of the mineral title (Western Weekly Reports, 1951a, p. 369).

The Supreme Court of Alberta, in this specific case, found Western Minerals to be the owner of the sand and gravel. However, this ruling created the *Sand and Gravel Act* (1951) which specified that, in most cases, the sand and gravel resources belong to the landowner. A newspaper reported the legislative evolution as "Defeat Move to Give Farmers Oil, Gas Rights". The article stated "Alberta farmers had been robbed of their storehouses [oil and gas] and were given back the trinklets [gravel]" (Edmonton Journal,1951).

Late in 1951, the landowner involved in the case with Western Minerals, appealed the ruling. The decision was reversed to give the ownership of the sand and gravel back to the landowner (Western Weekly Reports, 1951b, p. 434). Western Minerals then appealed this decision in mid-1952, to the Supreme Court of Canada, but the decision remained the same with the landowner retaining the rights to the sand and gravel (Supreme Court of Canada, 1953).

Clay and marl extraction administration were also transferred to the Department of Lands and Forests in 1961, when the rights to these two minerals were added to the surface ownership through a court ruling that led to the enactment of the *Clay and Marl Act*. The practice of the Crown and municipalities compensating surface owners for clay as fill material used in road construction was the rationale that supported this legislation (ENR, 1977).

In 1980, the *Sand and Gravel Act* and the *Clay and Marl Act* were incorporated into the *Law of Property Act*.

Present Alberta Legislation Affecting Aggregate Resources

Mines and Minerals Act

The *Mines and Minerals Act*, enacted in 1949, is currently administered under the Department of Energy. The Act gives the minister of the department the authority to allocate the minerals of Alberta, but, although it stipulates that sand, gravel, clay, and marl are minerals, these materials are exempted from the Act by virtue of the *Law of Property Act* (Alberta Government, 2004a, Section1(1)(p)(ii)(A)).

Law of Property Act

The *Law of Property Act*, enacted 1980, replaces the *Sand and Gravel Act* by repeating the portion of the *Sand and Gravel Act* that defined the ownership of sand and gravel resources of Alberta. This right is based on the traditional use established by the homesteaders (ENR, 1977).

> *"Sand and gravel*
> *58(1) The owner of the surface of land is and is to be deemed at all times to have been the owner of and entitled to sand and gravel on the surface of that land, and all sand and gravel obtained by stripping off the overburden or excavating from the surface, or otherwise recovered by surface operations.*
> *(2) The sand and gravel referred to in subsection (1) is deemed not to be a mine, mineral or valuable stone but is deemed to be and to have been a part of the surface of land and to belong to the owner of the surface."* (Government of Alberta 2004b, Part 7, Section 58)

The statement that sand and gravel "is not deemed to be a mine, mineral or valuable stone" implies that these resources are of lesser value, especially when other legislation emphasizes the conservation of most of the other natural resources (see section entitled "Legislation Protecting Natural Resources). As an example, soil, a resource also conveyed to the owner of the surface, is protected by the *Soil Conservation Act*, which serves as a notice to the landowner that they are responsible for the management of the soil.

The *Law of Property Act* also apportions the regulation of aggregate resources to three different government departments (Environment, Energy, and Sustainable Resource Development) along with each municipal authority. As a result, different standards exist for similar operations. For example, on private land, the *Environmental Protection and Enhancement Act* (EPEA) is focused on a reclamation objective for sand and gravel extraction operations. On public land, because the aggregate resources are public assets, the management objective for the sand and gravel resources becomes a government mandate under the *Public Lands Act*.

Further complications are caused by the description used to define sand and gravel. Whereas most aggregate resources in Alberta are unconsolidated sand and gravel deposits, there are instances where the boundary between the minerals and surface materials has to be determined by a geological assessment, then the appropriate ministry allocates the resource. An example is the surface or near surface silica sands of the Peace River Formation. The Peace River silica sand is unconsolidated material that has been exposed by erosion in the river valley. Even though the silica sands can be "*obtained by stripping off the overburden or excavating from the surface, or otherwise recovered by surface operations*" (Section 58(1) Law of Property Act), the sands were allocated as a mineral after a geological assessment determined the materials belonged to a Cretaceous sedimentary formation (Figure 13).

On Figure 13, an oil sand horizon, not actually present in the Peace River stratigraphy, has been fictitiously added to illustrate that there could be a question of resource ownership based on the wording of the *Law of Property Act*, because the oil sands could also be "*obtained by stripping off the overburden or excavating from the surface, or otherwise recovered by surface operations*".

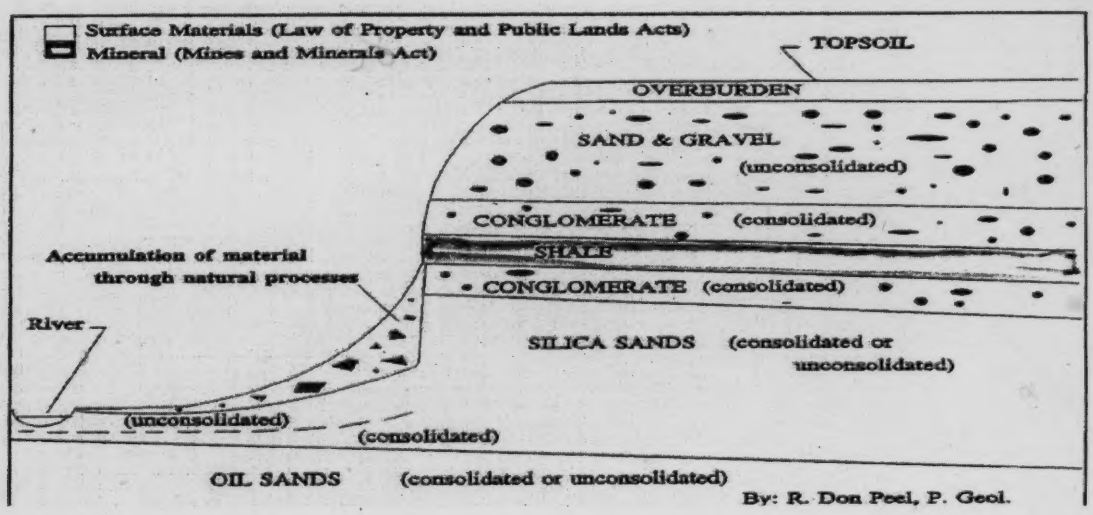

Figure 13: Areas where the boundary between surface materials and minerals require an interpretation of depositional history (Peel, 1992).

Thus the *Law of Property Act* splits the aggregate resources into four categories:

a) bedrock deposits;

b) surficial deposits including clay, marl, sand, and gravel;

c) deposits that cannot be declared either a mineral nor a surface material until the geological history has been determined;

d) deposits with the characteristics of both a mineral and surface material (e.g., colluvium).

In an attempt to clarify the difference between surface materials and minerals, *A Guide to Surface Material Resource Extraction on Public Land* defines surface materials as "*gravel, sand, silt, clay, marl of a surficial depositional history that is not associated with the bedrock formation*" (Alberta Government, 2002-2004, p. 6).

Due to the variation of geological settings throughout Alberta, either SRD or Energy is subject to committing "*ultra vires*" if the rights are granted under the wrong legislation. Ultra vires is a legal term used when an authority acts beyond the scope of their legal power. An example of an ultra vires occurred when the rights to "clay" were allocated under the *Public Lands Act* by SRD, only for it to be discovered later that the clay was a weathered horizon of the Whitemud Formation. The rights then had to be

transferred and granted under the *Mines and Minerals Act* by Energy. In essence, the legislation complicates achieving resource development practices by de-emphasizing the value of aggregate resources, dividing responsibility for resource management between different ministries, and offering little protection of these surface and near-surface resources from any surface developments that would restrict access to extract these resources.

Environmental Protection and Enhancement Act (EPEA)

The *Environmental Protection and Enhancement Act* (EPEA) is administered by the Department of Environment. Under the *Conservation and Reclamation Regulations,* approvals must be issued for sand and gravel extraction operations 5 hectares or larger on all lands not administered under the *Public Lands Act* (private land, federal land, and provincial lands held by titleholders in the name of government agencies other than the ministry administering the *Public Lands Act*). Because the rights to aggregate resources belong to the landowner, the objective of the EPEA is environmental protection through conservation of topsoil and reclamation of land disturbed by extraction operations. The EPEA does not acknowledge the value of the aggregate resources.

Applications for approvals under these regulations are required to give public notice by advertisement in local newspapers.

This approval process puts the resource developer at the mercy of public opinion. The developer has to counter public opposition by determining overall economic and environmental consequences, without any government assistance. As an example, a resource developer that had already obtained an EPEA approval to mine sand and gravel resources in the Calgary area, recently had its approval dismissed as a result of a complaint from a single member of the public who lived half a mile from the proposed extraction site. To date, the company has paid out in excess of $1 million in legal fees to deal with the complaint (ASGA, 2004).

Under this process, minority opinion can block resource development initiatives that may impose less of an environmental, economic, or social impact than alternative choices. Resource development, an important component towards sustainable development, will only be achieved if a developer is prepared to meet the large

expenditures of determining the environmental, economic, and social aspects of a resource extraction proposal. Developers who do follow this costly process are then risking their investment on a decision of an appeal panel, which may not be familiar with sustainable development parameters.

Public Lands Act

The *Public Lands Act* is administered by the Department of Sustainable Resource Development (SRD). Surface rights to public land and surface materials, including clay, silt, sand, gravel, marl, and peat, are allocated under this Act and regulated under the Fees and Disposition Regulations of the Act.

Applications for Surface Material Leases (SML) are approved or rejected by the "land managers" of a number of district offices throughout Alberta. All applications pertaining to resource extraction are referred to other resource agencies responsible for water quality, sustenance of fish and wildlife, and in some cases the Department of Transportation which may have a reservation on the lands being applied for. All applications are referred to the municipal authority as well, which usually stipulates that the SML holders are subject to obtain a development permit from the municipality. SML applications are dealt with on a "first come, first served basis".

The *Public Lands Act* gives some indication of resource priority under Section 82 (1) of the Act, where it is stipulated that if a "lease" for any purpose is issued

> " *the Minister* [of the Public Lands Act] *may cancel a* [the issued] *lease or withdraw any part of the land contained in a lease...*"
> *"(a) when, except in the case of a lease conveying rights to sand, silica sand, topsoil, peat, gravel, clay or marl, the Minister is satisfied that the land contained in the lease or to be withdrawn from it contains sand, silica sand, topsoil, peat, gravel, clay or marl in commercial quantities"* (Alberta Government, 2004e).

The legislation gives "surface materials" (including sand and gravel) priority in cases where other landuses have been established. However, this priority is not as empowering as in the case of land being deemed "irrigable". Here legislation appears to give the agricultural purpose an even higher priority than resource development by stating:

"(1)(d) when the land contained in the lease or to be withdrawn from it is, in the opinion of the Minister, irrigable in whole or in part,

(4) ..., no compensation is payable to the lessee" (Alberta Government, 2004e).

In the case of land containing aggregate resources, compensation is to be negotiated and paid by the developer.

Section 82(1)(a) is the only reference to aggregate resources in the *Public Lands Act*, and the Act does not include any reference to conservation objectives for aggregate resources, as is the case in legislation pertaining to the other natural resources (see "Legislation Protecting Strategic Resources").

Municipal Government Act

The *Municipal Government Act* (MGA) is another Act that provides regulatory powers over sand and gravel extraction operations in Alberta. This Act is administered by the department of Municipal Affairs, and allows each municipality to control and regulate all development within their designated areas, including issuance of Development Permits for resource extraction operations (Alberta Government, 2004c).

As with approvals under the EPEA, applications for development proposals, including resource extraction operations, are advertised in the local newspapers, and 30 days are allowed for a response to any proposals. Even if one member of the public raises concerns, a public hearing is ordered. The proponent of the development proposal must display how any public concern is to be addressed. The public can voice their concerns at the hearing and they are also are given another 30 days to submit written concerns related to the proposal.

This process is similar to the EPEA procedure where one public member, by simply filing a compliant against a proposal, can prevent a resource development initiative that would utilize resources to their full potential.

Water Act

The *Water Act* is relatively new legislation that will have a major impact on aggregate resource development because it calls for management plans focused on protecting the water resources of Alberta. Sand and gravel deposits are a product of water

flows (rivers) and also provide the medium associated with subsurface water resources (aquifers). This legislation will likely increase the difficulty of obtaining approvals to extract aggregate resources by giving the water resource priority, even in cases where the balance of the environmental, economic, and social aspects favor resource extraction, or where resource extraction could be conducted within a tolerance level that maintains the water resource requirements. The B.C. Mining Task Force is recommending that more aggregate be extracted from the Fraser River to supply the aggregate demand, in conjunction with providing public safety related to possible flooding (Aggregates & Roadbuilders, 2004 p.4).

Present Federal Legislation Affecting Aggregate Resources

Fisheries Act

The *Fisheries Act* is administered by the federal Department of Fisheries and Oceans (DFO). Any development that can cause alteration, disruption, or destruction to fish habitat requires approval under the *Fisheries Act.* DFO recently set up offices in Alberta to oversee development that has the potential to affect fishery resources. This legislation creates a perception that the fishery resources take priority over other resource values. Obtaining a resource development approval under the Act is also difficult because no informational requirements have been developed for such a proposal. As a result, resource developers (including Alberta Transportation) have abandoned extraction operations associated with watercourses upon the arrival of DFO staff in the province in 2000. In essence, the *Fisheries Act* discourages resource developers to risk capital expenditures towards environmental baseline studies that may not be accepted by DFO. From this perspective, environmentally-sound development will not be achieved, because there will be cases where resource extraction could be conducted from a balanced environmental, economic, and social approach, if proper common assessment standards were developed and consistently prescribed by the regulatory agencies.

In 1998, Alberta Environment appointed a committee to develop a policy related to aggregate extraction from waterbodies. The resulting policy, which still has to be endorsed by DFO, gives the aggregate resource sector an opportunity to design and qualify operations that may maintain or enhance fish habitat.

Canadian Environmental Assessment Act

The *Canadian Environmental Assessment Act* (CEAA) addresses sustainable development by encouraging "*authorities to take actions that promote sustainable development and thereby achieve or maintain a healthy environment and a healthy economy, and to ensure that there be an opportunity for public participation in the environmental assessment process*" (Government of Canada, 2004a).

Aggregate resource extraction operations subject to the CEAA regulations are stone quarries, or gravel or sand pits with a production capacity of 1,000,000 t/yr or more, as stated in Part V of the "Comprehensive Study List Regulations" under CEAA (Government of Canada, 2004b). The proponent of such an operation must carry out a "comprehensive study" which addresses the environmental, social, and economic factors of the initiative.

No known sand and gravel operations in Alberta have been through the CEAA process.

Legislation Protecting Natural Resources

Several laws (Energy Resources Conservation Act; Fisheries Act; Forest and Prairies Protection Act; Forest Reserves Act; Forests Act; Gas Resources Preservation Act; Historical Resources Act; Natural Resources Conservation Board Act; Oil and Gas Conservation Act; Oil Sands Conservation Act; Soils Conservation Act; Water Act; Wilderness Areas, Ecological Reserves, Natural Areas and Heritage Rangelands Act; Wildlife Act) have been enacted to give the Alberta government the ability to monitor and conserve identified natural resources. These include energy, fish, forests, gas, historical resources (e.g., artifacts, historic sites), oil, oil sands, soil, ecosystems (wilderness, natural, environmental, and heritage areas), water, and wildlife. Aggregate resources are not covered under such legislation; therefore, all other resource values have a tendency to be given a higher priority. Policy creation is bound by the legislation and due to the lack of specific legislation giving sand and gravel resources management

direction, there has been little policy creation to identify these resources in the sustainable development framework.

In 1998, a citizen successfully charged, under the federal *Fisheries Act*, an aggregate resource producer with the destruction of fish habitat in the North Saskatchewan River. The defendant was acquitted of the charge due to an officially induced error created by a lack of coordination between the provincial and federal governments' approval processes (Utas, 1998; Wilson, 1998). The court action along with the implementation of a 100 m buffer as an operating condition for extraction operations adjacent to waterbodies, initiated the formation of the "Extraction of Aggregate From Waterbodies Committee" (1998). The Committee's role is to develop policy related to the activity. The Committee is headed by a representative from the Department of the Environment (Water management), with representation from the Departments of Transportation and Sustainable Resource Development (SRD).

In 2000, the Fish and Wildlife Division of SRD initiated a study by an environmental consulting company to assess the environmental effects of aggregate extraction from watercourses and floodplains within Alberta. In order to assess the effectiveness of regulatory guidelines, the study focused on the following aspects:

- *the current legislation, regulations and guidelines that govern the extraction of Alberta's aggregate resource;*
- *the current legislation, regulations and guidelines that govern the extraction of the aggregate resource in other jurisdictions within Canada as well as internationally;*
- *the adequacy of the current Alberta legislation, regulations and guidelines in effectively mitigating environmental effects, and:*
- *the effectiveness of current legislation, regulatory guidelines in mitigating the effects of aggregate extraction on the aquatic ecosystems.* (EnviroMak, 2000a, p. 3 Component 3)

The conclusion of the study stated that:

- there are some deficiencies in overall effectiveness of Alberta's regulations and guidelines; however, they are superior compared to many other jurisdictions.
- several useful guidelines and regulatory conditions were being applied to resource extraction operations; however, there were inconsistencies between regions and/or individual regulators.

- no baseline inventories, effect assessments, or monitoring are required to determine if any of the operating conditions for resource extraction are effective.
- compliance with operating conditions may not be occurring. (EnviroMak, 2000a, p. 41, Component 3)

One of the eight recommended actions of the study was to create an *Aggregate Minerals Conservation Board*. The study also suggested that a long-term management plan could be developed to conserve and allocate aggregate usage while ensuring that the integrity of Alberta's watercourses and floodplains is maintained (EnviroMak, 2000b, p. iv Component 5).

Legislation in Other Jurisdictions

Many jurisdictions are assessing aggregate resource extraction regulations in response to the increasing number of land-use conflicts between the resource sector and the public. In Canada, Manitoba and British Columbia recently appointed task groups to assess the aggregate resource sector. The Gwich'in Settlement of the NWT hired a consultant for the same reason.

In order to assess Alberta's aggregate resource management position, comparisons may be made with legislation in other jurisdictions in Canada (Table 13, p. 68).

Two different approaches have been taken by provincial governments regarding the ownership of aggregate resources. Manitoba and Quebec define all such materials as minerals, and claim them as a Crown resource. In contrast, the other provinces have conveyed the rights to sand and gravel resources, along with other specified materials, to the land titleholder. New Brunswick, Prince Edward Island, and Nova Scotia also exclude building or construction stone from their definition of minerals, which could include bedrock sources that have been retained as minerals by other jurisdictions including Alberta. In 1966, the Quebec government recognized sand and gravel as public assets and declared provincial ownership of all surface minerals, essentially expropriating resources that had previously been allocated to land owners (Government of Quebec, 2000).

Table 13: Comparison of Mining Regulations in the Provinces of Canada.

Province/ Regulatory Ministry	Aggregate resource legislation	Legislation details	Aggregate Production (% sand and gravel) 1998[1]	Royalty rate	Inventory management	Inventory coverage	References
British Columbia Ministry of Energy & Mines	Mines Act and Land Act (production over 250,000 tonnes/yr subject to Environmental Assessment Act)	Mineral Tenure Act: excludes sand or gravel. Lands Act: protects sand and gravel on Crown land.	38,229,000 t (83%)	Varies with market price	B.C. Geological Survey, Energy and Mines, Ministry of Transportation, B.C. Land and Water	Five maps produced (3% of province)	Government of British Columbia, 2002; Queens Printers, 2003a,b
Alberta Alberta Environment (private land); Department of Sustainable Resource Development (public land)	Environmental Protection and Enhancement Act and Public Lands Act	Mines and Mineral Act: excludes sand & gravel. Law of Property Act: sand and gravel owned as surface rights. Public Lands Act: Sand and gravel are classed as "surface materials".	44,631,000 t (99%)	$0.60/cu.yd. ($0.78/m^3, $0.48/t) sand and gravel	Alberta Geological Survey	48% of Province inventoried (18% @ 1:50,000 scale)	Government of Alberta, 2004a–d
Saskatchewan Department of Agriculture, Food and Rural Revitalization	Sand and Gravel Act and Quarrying Regulations	Mineral Resources Act: includes sand & gravel. Mineral Taxation Act: excludes sand & gravel. Sand and Gravel Act: sand and	12,032,000 t (100%)	$0.20/$m^3$ ($0.12/t) if processed and manufactured into finished products in Sask. 6% of selling value when	No provincial inventory program	Southern portion of the province mapped for aggregate resources in 80s.	Government of Saskatchewan, 2003a–d

Province/ Regulatory Ministry	Aggregate resource legislation	Legislation details	Aggregate Production (% sand and gravel) 1998[1]	Royalty rate	Inventory management	Inventory coverage	References
Saskatchewan cont.		gravel owned as surface rights. Crown Minerals Act: excludes sand & gravel.		shipped from Sask.			
Manitoba Department of Industry, Trade and Mines	Mines and Minerals Act, Planning Act	Mines and Minerals Act: includes sand and gravel. Provincial Land Use Policies Regulations of the Planning Act protects the aggregate resources.	15,127,000 t (67%)	$0.35/t sand and gravel; $0.25/t crushed stone; $0.10/t collected for pit and quarry rehabilitation program.	Manitoba Geological Survey	35% coverage.	Manitoba Statutes, 2003a,b
Ontario Ministry of Natural Resources; Ontario Aggregate Resource Corporation	Aggregate Resources Act. Planning Act (includes protection of mineral potential lands)	Mining Act: includes sand & gravel. Mining Tax Act: excludes non-aquriferous sand or gravel. Aggregate Resources Act defines "aggregate".	138,875,000 t (64%)	$0.25/t sand and gravel; $0.06/t licensing fee	Ontario Geological Survey	70% of populated part of the province inventoried.	Ontario Aggregate Resources Corporation, 2003; Ontario Ministry of Northern Development and Mines, 2002; Ontario Ministry of Transportation, 2001; Ontario Statutes, 2000, 2002a,b
Quebec Ministere des Ressources Naturelles	Mining Act	Mining Act: defines sand and gravel as a "surface mineral substance". Quebec government	59,539,000 t (46%)	$0.36/t sand, gravel, clay and other unconsolidated deposit; $0.40/t stone	Géologie Québec	50% of the populated area has been covered (1:50,000 scale).	Quebec Statutes, 2002

Province/ Regulatory Ministry	Aggregate resource legislation	Legislation details	Aggregate Production (% sand and gravel) 1998[1]	Royalty rate	Inventory management	Inventory coverage	References
Quebec cont.		expropriated sand and gravel resources on private land in 1966.		and sand used as silica ore or in cement; $0.21/t mine tailings, crushed stone, other			
New Brunswick Department of Environment and Local Government (private land); Department of Natural Resources & Energy (public land).	Community Planning Act (private land). Quarriable Substance Act and Regulation 93-92 (public land).	Mining Act excludes sand and gravel from the definition of a mineral. Quarriable Substance Act defines "quarriable substance".	7,836,000 t (55%)	$0.25/t	Department of Natural Resources and Energy	100%	New Brunswick Statutes, 1991, 1993
Nova Scotia Department of Environment (private land); Department of Natural Resources (Crown land)	Metalliferous Mines and Quarries Regulations Act	Mineral Resources Act excludes sand and gravel. Metalliferious Mines and Quarries Regulation Act includes building materials.	10,028,000 t (24%)	$0.90-$2.00/m^3 (sand); $0.60-$1.20 /m^3 (gravel)	Department of Mines	100%	Nova Scotia Department pf Natural Resources, 2002a,b,c; Nova Scotia Statutes, 1989, 1999, 2001
Prince Edward Island Department of Fisheries, Aquaculture & Environment	Environmental Protection Act (Excavation Pits Regulations)	Mineral Resources Act excludes sand and gravel, ordinary stone, building or construction stone.	199,000 t (100%)	$0.50/$m^3$ (beach sand only)	NA	No inventory	Prince Edward Island Statues, 1988, 2003a,b

Province/ Regulatory Ministry	Aggregate resource legislation	Legislation details	Aggregate Production (% sand and gravel) 1998[1]	Royalty rate	Inventory management	Inventory coverage	References
Newfoundland & Labrador Department of Mines and Energy	Quarry Materials Act	Mineral Act: excludes "quarry materials" — used for civil construction or for agricultural purposes. (Newfoundland) Labrador — includes a mineral rock or stone being cut or polished for use as an ornament, personal adornment, or decoration.	6,320,000 t (59%)	$0.30/m^3 (private and public land)	Newfoundland and Labrador Geological Survey	100% of Newfoundland inventoried.	Newfoundland Regulations, 2000; Newfoundland Statutes, 2002a,b
Yukon Department of Energy, Mines and Resources	Federal Territorial Lands Act	Federal Territorial Quarrying Regulations	690,000 t (100%)	$1.25/m^3 (gravel); $1.50/m^3 (sand, sand and gravel)	Geological Survey of Canada	NA	Natural Resources Canada, 2003
North West Territories Department of Indian Affairs and Northern Development, and land claim settlement authorities	Federal Territorial Lands Act or land claim areas	Federal Territorial Quarrying Regulations/ Gwich'in Settlement Area Land Claim Agreement defines "specified substances".	755,000 t (55%)	$1.25/m^3 (gravel) $1.50/m^3 (sand, sand and gravel)	Geological Survey of Canada	NA	Natural Resources Canada, 2003

Province/ Regulatory Ministry	Aggregate resource legislation	Legislation details	Aggregate Production (% sand and gravel) 1998[1]	Royalty rate	Inventory management	Inventory coverage	References
Nunavut Sustainable Development, Department of Indian Affairs and Northern Development	Federal Territorial Lands Act or land claim areas	Federal Territorial Quarrying Regulations	NA	$1.25/m^3 (gravel) $1.50/m^3 (sand, sand and gravel)	Geological Survey of Canada	NA	Natural Resources Canada, 2003

[1] Statistics Canada 2003

Royalty rates for aggregates vary widely between the provinces, from $\$0.20/m^3$ (Saskatchewan) to $\$1.50/m^3$ (Yukon and Northwest Territories), compared with $\$0.78/m^3$ in Alberta. There appears to be no systematic basis for these rate variations, and although different materials have different royalty rates, none of the legislations specify the parameters used to distinguish these materials. For example, clay, silt, sand, and gravel have different specifications under different scale systems. The Wentworth Scale divides sand from gravel at a 2 mm grain size, whereas Alberta Transportation sets the division at 5 mm, and Ontario's Transportation Ministry uses 4.75 mm; most jurisdictions do not include a category for silt. In some instances, such as silica sand or manufacturing clay, the royalty rate is higher if the resource has a quality specific to a product niche. However, this philosophy has not been extended to high quality aggregate resources, such as those suited for concrete or asphalt production.

Resource management standards also vary across Canada, lower standards typically correlating with unreliable production reporting. For example, Alberta's aggregate production rate, as measured by Statistics Canada, was reported to be 19% lower than in a survey conducted by the Alberta Geological Survey (Edwards, 1998). An in-depth study on the royalty rate and fee structure for sand and gravel production (Miller, 1972), also noted there was a divergence between the federal statistics and provincial records on sand and gravel production rates. For the 1970 production rate, the federal figure was 64% lower than the province's estimate (Miller, 1972, p. 13). Production rates are important to gauge regional resource depletion rates, from which road construction, maintenance, and other costs can be predicted. This knowledge could be balanced against public opposition or competing resource values (e.g., fish habitat) when making resource development decisions.

Ontario, historically the largest provincial aggregate consumer, has addressed the problems of resource management through enactment of the *Aggregates Resources Act* (Ontario Statutes, 2002a), the only Canadian statute giving specific recognition to the value of aggregate resources. The purposes of this Act are to "provide for the management of aggregate resources, to control and regulate aggregate operations on Crown and private lands, to require the rehabilitation of land from which aggregate has been excavated, and to minimize adverse impacts on the environment in respect of

aggregate operations" (Ontario Statutes, 2002a, sec. 2). All these functions are the responsibility of the Ontario Ministry of Natural Resources, which has entered into a partnership with the Aggregate Producers of Ontario to create The Ontario Aggregate Resource Corporation (TOARC). This organization manages the Aggregate Resources Trust, which provides funds for rehabilitation of abandoned pits and quarries, conducts research on aggregate resource management, distributes a fee levy ($0.06/t) to the Crown and municipalities, and the educates and trains people engaged in or interested in different aspects of the aggregates resource sector. The only other province to protect its aggregate resources through similar legislation is Manitoba, where the Provincial Land Use Policies Regulation of the *Planning Act* restricts conflicting development in areas with "quarry" potential.

A key factor in improving resource management is better resource inventory. A number of provinces have active aggregate resource inventory programs managed by their geological survey agencies, but experience shows that available inventory information is often not incorporated into planning processes. In addition, many provincial and federal geological surveys are under severe financial constraints, and resource inventory and depletion rates are incompletely monitored. For example, in Alberta, inventory information provided by the Alberta Geological Survey (AGS) has seldom found its way into any planning process, even in the latest pro-development plan of Sturgeon County (see Chapter 5). Alberta's "Regional Strategies" initiative (Alberta Government, 2001–2003a) may be an opportunity to integrate the AGS data into the "Integrated Resource Management" process (Alberta Government, 2001-2003b), even though the data are outdated and incomplete" (Richards and Peel, 2004).

British Columbia

Aggregate consumption in British Columbia is the second highest of the provinces by volume, slightly higher than Alberta and with about 15% of the production coming from bedrock sources (Statistics Canada, 2003). The British Columbia Minister of Energy and Mines appointed the Aggregate Advisory Panel to make recommendations on:

- *The provincial and local governments' roles and responsibilities in a range of aggregate-related issues, including identifying and protecting aggregate resources to meet future needs;*
- *Factors and criteria to be taken into account when reviewing and approving aggregate operations and the respective authorities for considering these factors;*
- *Improvements and amendments to the permitting processes so decisions are more timely, efficient and less contentious;*
- *Policy and statutory changes necessary for any the forgoing issues.* (Aggregate Advisory Panel, 2001).

The Panel's report contained 47 recommendations, including new legislation entitled the *Aggregate Resource Management Act*, to define the planning process, empower regional districts to use the process to plan, identify appropriate funding for both planning and mitigation of community impacts, and allow the province to designate aggregate reserve zones. It was recommended that the government should conduct an inventory of aggregate resource potential along with environmental constrains. Each regional district should complete 30-year management plans to which municipalities establish zoning to enable resource extraction.

Apparently the new B.C. government (elected in June 2001) did not act on this report, and a reassessment of the aggregate resources will take place under a government review of the mining sector. The Mining task force was struck in June 2003 and the Aggregate Producers Association of British Columbia is hopeful that the review will allow positive changes in the governance of the aggregate resource sector (Aggregates & Roadbuilding, 2004 p.4).

Manitoba

In late 2001, the Manitoba Government appointed a Mining Task Force, to review the mining industry of the province. The recommendations of the review were of a general nature towards the mining sector, even though the aggregates sector was singled out in the review (Manitoba Government, 2003b). Recommendations related to sustainable development focused on the environmental perspective because economic development considerations were treated in a separate category. The economic development recommendations stated:

> *"the government should consider targeted educational initiatives to build community support and critical mass, and develop the workforce of the future in communities where the mineral and petroleum industries are predominant. The government should also work in partnership with other community organizations, such as the Minerals Society of Manitoba to encourage greater citizen awareness of the industry"* (Manitoba Government, 2003a).

The Manitoba government views sand and gravel as minerals. Royalties are paid to the government for the resource removed from both private and public land.

Gwich'in Settlement (57,000 km^2 of northwestern North West Territories)

The Gwich'in Settlement is an example of a new juridiction managed by indigenous people. The land management practices incorporate traditional values into modern resource development parameters. The Settlement shares a similar geological setting to Alberta for aggregate resources, in that many are Laurentide glacial melt deposits (Dyke and Priest, 1987).

In May 2001, the Gwich'in Tribal Council invited the author to conduct an assessment of their policy and the local geology within the Gwich'in Settlement Area (GSA), primarily related to their mineral aggregate resources. Although the population of the settlement and the size of the planned developments are small, with the possibility of the McKenzie pipeline being routed through the settlement area and the opportunity for further mineral development and tourism, the future demand for construction materials is potentially high.

The *Gwich'in Land Use Plan,* which directs the GSA's management processes, sets the stage for integrated resource management. Aggregate resources have been addressed as Recommendation 27 of the Planning Board in the *"Implementation Plan Outline"* of the *Gwich'in Land Use Plan.* The recommendation states *"that the Gwich'in Tribal Council prepare a sand, gravel and rock (crushed rock and carving stone) management plan for Gwich'in Private Lands in the Gwich'in Settlement Area that would include specific management plans for operating pits."* In addition, Recommendation 26 states that the Department of Indian Affairs and Northern Development prepare a sand, gravel and rock management plan for Crown lands.

As in many other jurisdictions, the GSA's management directives separate the status of the aggregate resources from other minerals, usually to prevent conflict with surface ownership rights. For example, sand, gravel, and rock resources are included as "specified substances" in the Gwich'in Comprehensive Land Claim Agreement (Section 18.1.1).

The Gwichin Land Use Plan appears to recognize the importance of the aggregate resources by identifying the need to prepare an aggregate resource management plan. However, there appear to be some similarities to the weaknesses of the Alberta management role. Firstly, the management function is not a budgeted program, nor is the function identified in the business plan. Secondly, the resources are handled differently to other minerals, which will create confusion in the administrative processes. Thirdly, there is no aggregate resource inventory of existing data, nor a plan to capture data as they are generated.

To initiate an aggregate program, the consultant's report contains 27 recommendations which include specifying a budget for a program to develop policy, dedicate a Geographic Information System (GIS) for data capture, compile existing resource inventory data, request and collect new data from other approval processes, monitor the program development, and incorporate the information into the planning processes (Peel, 2001).

Ontario

Ontario appears to be the only province that gives legislative recognition to its aggregate resources. Ontario is the highest consumer of aggregates in Canada and has responded by increasing the resource's profile by implementing the *Aggregate Resources Act* to ensure effective resource management. The *Planning Act* includes the *Mineral Aggregate Resources Policy Statement (MARPS),* which directs municipalities to incorporate the aggregate resource information into their planning processes.

> *"Aggregate resources management in Ontario has attempted to achieve its objective of "ensuring the availability, conservation and orderly development of aggregate resources with minimal adverse impacts on society and the environment". Strategically, an integrated*

resource management approach has been employed, focusing on three main topic areas: 1) resource conservation; 2) industry regulation; and 3) planning for aggregates" (Bobrowsky et al., 1996).

The process that Ontario has adopted appears to be modeled on California's legislative approach to aggregate resource management. The latter process recognizes the importance of the resource and incorporates geological data into the planning process.

California, USA

California appears to be the first jurisdiction in North America that incorporated geological information into their municipal planning process. The *Surface Mining and Reclamation Act* (SMARA,1975) gives municipalities one year to incorporate mineral resource data, collected by the state geological survey, into their planning process to protect the access to the resources (California Government, 2003a).

A California Geological Survey (CGS) website states "Aggregate (sand and gravel, crushed stone) is currently the most important mineral resource consumed in California" (California Government, 2003b). The CGS is currently using satellite-derived information to inventory the resources.

California is one of U.S.'s top aggregate resource producers (Langer, 2000), but the high demand still requires the state to import aggregate from as far away as British Columbia.

Government Policies Supporting Sustainable Development in Alberta

A strategy towards sustainable development, as outlined by Agenda 21, is an "integrated approach to the planning and management of land resources" (UNCED, 1992). The Alberta government's "activities" in the following areas are evaluated below in the context of aggregate resources.

Developing Supportive Policies and Policy Instruments

The government of Alberta endorsed a policy entitled "*Alberta's Commitment to Sustainable Resource and Environmental Management*" (1999). This has set the direction for the management of Alberta's natural resources and environment for the "greatest public benefit" (Alberta Government, 1999a, p.1). The policy indicates that "*non-*

renewable resources shall be managed in a manner to maximize benefits to Albertans", and that "*resources such as trees, minerals, wildlife, water, fish, range, public land and plants, shall be managed in a manner that addresses their interdependence and recognizes that the use of one resource can affect the other users and other resources*" (Alberta Government, 1999a, p.4).

These statements do not mention sand and gravel resources, either on public or private lands. As a result of this non-inclusion of aggregate resources in policy directives, access to and allocation of surface materials are increasingly being affected by other land uses or resource values. The Alberta Sand and Gravel Association have stated "*gravel deposits near urban centres are being depleted much faster than replacement sources are being approved*" (ASGA, 1994). Also, in the context of development, a small rural community overriding a resource extraction proposal to service a large urban center is an example of the social aspect taking precedence over the environmental and economic considerations.

The government's policy also states, "*sustainable development is best achieved when rules, roles and resolve of the key parties are clear and understood*" (Alberta Government, 1999a, p.8). Under the heading of "*effective and up-to-date legislative/regulatory regime*", policy and legislation are:

- *to incorporate new and innovative approaches,*
- *to be streamlined and simplified,*
- *to be reviewed,*
- *to be made accessible to industry, community, and the public,*
- *to be enforced* (Government of Alberta, 1999a, p. 8-9).

Therefore, "*Alberta's Commitment to Sustainable Resource and Environmental Management*" presents an opportunity for recognizing and including aggregate resources in an integrated resource management approach.

Strengthening Planning and Management Systems

Along with the government directive "*Alberta's Commitment to Sustainable Resource and Environmental Management*" (1999), an implementation plan was developed by the Integrated Resource Management Implementation Committee. "*Alberta's Commitment to Sustainable Resource and Environmental Management: Implementation Plan*" (1999) states that effective and fair decision making processes and

an up-to-date legislative/regulatory regime will be accomplished through Integrated Resource Management (IRM)(Alberta Government, 1999b). As in the policy, the implementation plan is silent on sand and gravel resources, stating "*Alberta's natural resources covered under IRM include air, public land, water, timber, fish, wildlife, range, oil, gas and mineral resources*" (Alberta Government, 1999b, p.1)

Although many of Alberta's resources have been addressed through IRM plans, the latest IRM format appears to be more comprehensive. The "*Northern East Slopes Sustainable Resource and Environmental Management Strategy*" (2003) is a pilot IRM under this new process. The Northern East Slopes Strategy (NESS) was initiated in 1999 by appointed government and non-government members called the Regional Steering Group (RSG)(Regional Steering Group, 2003). This process is guided by the "Six Steps to Sustainable Development" (Regional Steering Group, 2003, p.4).

Step 1: A Regional Vision
Step 2: Strategic Direction for Integrated Resource Management
Step 3: A Cumulative Effects Management System
Step 4: Building an Administrative Bridge
Step 5: Building a Communications Bridge
Step 6: Learning into the Future (Regional Steering Group, 2003, p.4-7).

To evaluate if aggregate resource planning and management processes are strengthened, the NESS should provide specific tools to address aggregate resources.

Promoting Application of Appropriate Tools for Planning and Management

"Indicators" can be viewed as planning and management tools. The NESS defines an "Indicator" as "*a measurable variable used to report progress toward achievement to a goal*" (Regional Steering Group, 2003, p. 62). Within the NESS, Appendix C lists several potential indicators.

Aggregate (sand and gravel) production has been identified as an "*Indicator*" for a "*healthy and sustainable economy*" with the goal of "*encouraging conditions that maintain opportunities for resource development*". The goal "*to optimize economic benefits and economic stability through diversification*" includes several Indicators (e.g., royalties, net regional product, employment by sector) that apply to the aggregate resource sector (Regional Steering Group, 2003, p.68).

Royalties received by the provincial government from 1993 to 2003, for surface materials, varies between $1.9 million to $4.8 million annually, with an average of $3.26 million per year. According to the accounting statistics, royalties received in the fiscal year April 1, 1998, to March 31, 1999, for SMLs, amounted to $3.5 million. Using the royalty rates of sand and gravel/sand, 7,343,700 tonnes are accounted for (the royalty rate for sand and gravel @ $0.48/ tonne being 99% of the returns and 1% reported as sand @ $0.28/tonne). This amount of royalty exempt material (public works projects) is estimated at 5,000,000 tonnes. The total of production from public land is conservatively estimated to be 12,500,000 tonnes.

As a check to verify the amount, Statistics Canada conservatively reports 43,998,000 tonnes of sand and gravel were produced in Alberta in 1998 (best correlation to the 1998-9 fiscal year reporting of Alberta). Adding the 19% for the unreported operators (Edwards, 1998) brings the volume to approx. 52,000,000 tonnes. The amount coming from private land then would be 52,000,000 minus 12,500,000 tonnes, or 39,500,000 tonnes. Using a comparison of the number of pits between public (approx 1500 pits) and private land (approx 3000), and assuming the average production would be proportional to the number of pits, it would appear the unreported production figures for public land could be around 7,000,000 tonnes or $3.5 million (royalty).

In the year 1999, the Susan Lake Public Pit, Ft. MacKay area, became operational. This pit is fully managed as each truck is scaled for product weight (there is no requirement for using scales on SML operations). The provincial royalties jumped from $2.9 million (1999) to $4.4 million (2000) mainly due to reported production from this pit. The 2000 production from Susan Lake Public Pit brought in $1.866 million or 42% of the total royalties.

For one pit to be contributing close to half of the provincial royalties for surface materials (the total royalty figure includes clay, peat, and marl production) and the fact that there appears to be a shortfall when comparing the conservative federal production rates in relationship to the provincial royalty figures, suggests that the honor system of reporting royalties is the cause of the shortfall.

These "Indicators" promote the development of known resources. However, the NESS has gone one step further with non-energy minerals by including the Indicator

"non-energy mineral reserve potential". As Edwards (1984) concluded in his cost-benefit analysis on aggregate resource inventory, this indicator should also be applied to aggregate resources.

The NESS addresses the inventory aspect of sand and gravel resources under "Wise Resource Use" in the mining sector by recommending the action to "*ensure that the aggregate resources (sand and gravel) near major regional communities are identified and protected for long-term supply options*" (Regional Steering Group, 2003, p.80). This facilitates the strategic direction stated as "*recognizing that mining is a temporary land use that allows other successor uses, allow the orderly, economic and environmentally sustainable extraction of basic raw material resources in key identified areas*" (Regional Steering Group, 2003 p.80). Unfortunately this statement does not address aggregate resources on public land, which are used by all the other resource development companies (e.g., oil, gas, oil sands, timber), and not necessarily near a major regional community. Aggregate resources relatively distant from regional communities, but close to rail lines, also have high development potential as alternate sources for large market centers.

Under "Wise Resource Use" the NESS does address "Urban and Residential Development" and "Commercial Tourism". However, aggregate production and transportation development do not appear to be tied into to these issue areas.

Overall, the inclusion of these items into the NESS is a step towards including aggregate resources into the integrated resource process.

Raising Awareness

Raising awareness is identified as Step 5 to sustainable development , which "*through the creation of Collaborative Partnerships, promotes continued communication, cooperation and consultation*" (Regional Steering Group, 2003, p.7). According to one of NESS's update releases (Alberta Government, 2002a), there is no indication of the aggregate resource sector being included in the list of stakeholders consulted.

Appendix E of the NESS includes a number of areas requiring change that are categorized as "implications to government", industry, communities, and environmental implications. The area best fitted to the aggregate development sector would be the

"Cumulative Effects Management System", which states that industry is required "to participate in regional management [decisions]" (Regional Steering Committee, 2003, p.148).

Promoting Public Participation

The NESS public consultation included public meetings in seven major communities in October, 2000 (Alberta Government, 2000), and in twelve communities in February, 2002, when 300 individuals attended public and stakeholder meetings (Alberta Government, 2002a). An independent survey reported overall awareness of the IRM had risen from 16% (2001) to 24% (2002). However, there was a lower overall awareness of the NESS in 2002 compared to the 2001 survey (Alberta Government, 2002b).

Strengthening Information Systems

This is an area of opportunity for the aggregates sector because a number of government agencies are collecting and/or storing information on these resources. The Department of Environment captures information on sand and gravel operations 5 hectares or larger on private land, Sustainable Resource Development captures information for all extraction operations on public land, the Department of Transportation has a database of all its extraction and potential extraction sites, the Department of Energy collects and captures the information for aggregate quarry operations, and the Alberta Geological Survey and the Geological Survey of Canada have aggregate resource inventories. Natural Resources Canada (NRCan) survey and receive annual data from many resource developers for Statistics Canada (Natural Resources Canada, 2002). However, there is very little data transfer between these departments.

As mentioned previously, the AGS conducted a comparative survey for Alberta's aggregate resource production in 1991 and concluded that the 1991 Statistics Canada production figures were 19% lower than the AGS's data. "*It is assumed that the production number (45,484,836 tonnes) generated from a combination of the AGS and NRCan surveys still represents a minimum amount of sand and gravel as some producers did not respond to the AGS survey*" (Edwards, 1998, P. 373).

The *Cumulative Effects Management System* has been developed for the NESS to "*foster an integrated, transparent and fair process for resource management that ensures the strategic regional direction is implemented and cumulative effects are addressed*". Under the area of cumulative effects assessment and management of the NESS, a number of ways to collect and share data have been identified. Defining "*a regional monitoring system based on appropriate indicators for economic, social and environmental goals whilst ensuring costs are proportionately shared between government, industry and other stakeholders*" is a listed direction where aggregate resources information would assist in achieving sustainable development (Regional Steering Group, 2003, p.37-38).

Strengthening Regional Cooperation and Exchange of Information on Land Resources

Approval processes for development used by the Department of Environment (private land), Sustainable Resource Development (public land), and municipal authorities (private and public lands) occasionally produce conflicting development conditions under the different approvals and do not factor in the cumulative effect aspect. The IRM process is intended to integrate and standardize these application processes. Under the NESS, the *Collaborative Partnerships* and *Sustainable Landscape Plans* are initiatives to strengthen regional cooperation and information exchange. These initiatives are described in some detail within the NESS document itself (Regional Steering Group, 2003, p.37-42).

To make the process transparent to Albertans, the stakeholders (e.g., any resource developer such as the Canadian Petroleum Producers or manager such as Ducks Unlimited) and public forums are summarized on the website address of www3.gov.ab.ca/env/regions/nes/strategy.html. Because this is a pilot process, the lessons learned will be incorporated into the preparation of strategies for other regions (Regional Steering Group, 2003, p.8).

Summary and Conclusions

According to Agenda 21, governance is an essential component to develop and implement sustainable practices. Many jurisdictions are responding by employing

integrated resource management programs. Through this procedure there is a need for accurate and standardized resource accounting.

In Alberta, it appears most of the natural resources are being identified and included in land use decisions by legislation and regulations, with the exception of aggregate resources. In fact, the legislation appears to devalue sand and gravel resources by stating they are neither "*a mine, mineral, or valuable stone*", and the rights to these resources are conveyed to landowners (Alberta Government, 2004b), usually without a resource value assessment. It appears this stems from an established traditional use by pioneers for homestead development. With all the other resources having legislated protection mechanisms, there is a tendency for other resource values to be given precedence over aggregate resources, even in cases where development of the aggregate resources would achieve substantial economical and environmental gains.

Through this legislation, the rights to these resources are split between private and public interests. When the rights are conveyed to private interests, primarily for surface development (residential or industrial uses), aggregate resource development is either lost or obtained at an increased cost. As an example, when resources are extracted from private lands to construct and maintain public infrastructure (roads), substantial amounts of public funding are used to "buy-back" these resources, without any return (royalties) to the Province. Unusual business dynamics also result when aggregate resources are available for a project from either private or public land locations. An amplification of this business discrepancy occurs when government (Alberta Transportation) purchases private property or reserves public land, containing aggregate resources, to protect and develop aggregate resources for highway construction. The situation requires a business analysis to assess possible cost benefits or losses to the Province and how the practices affect private business ventures. Quebec's government responded to this apparent business anomaly by expropriating the resource rights back to Crown ownership, for public benefit.

The Law of Property Act, through the exclusion of sand and gravel from the mineral family, has also split the regulation of aggregate resources to a number of government agencies. Alberta Environment, regulates resource extraction operations on private lands with the objective to ensure environmental integrity is restored upon the

completion of the operation, which can be accomplished without any need for monitoring resource potential or production values. Sustainable Resource Development (SRD) allocates the sand and gravel resources on public land through a *first-come-first-serve* basis, with an honor system for reporting production rates. Alberta Transportation and municipal authorities have priority to the aggregate resources, on public land, over private resource development proposals in some instances. Alberta Energy allocates aggregate resources when bedrock sources are used. In an increasing number of cases there is a need for a geological assessment to determine if a deposit is a mineral to be allocated by Energy, or surface material, allocated by SRD. Municipalities also regulate aggregate resource extraction operations through their development permit requirements. Under these different regulatory bodies, different standards exist, resulting in an increasing number of complications being experienced, without an overall account of resource potential and production (resource accounting). Natural Resources Canada is the only production data collector; however, due to the variable standards within each province and nationally, the data they collect are subject to discrepancies. The AGS's assessment of the federal statistics related to Alberta's sand and gravel production, shows a 20% variation.

Overall, the activities toward integrated resource management, outlined by Agenda 21, strengthen any governance model towards sustainable development. Of all the governance procedures researched, California appears have the best legislation to integrate geological data with the planning processes. For Alberta, the legislation has been counterproductive towards including the aggregate resources into the activities of developing supportive policies, strengthening planning and management systems, promoting application of appropriate tools, raising awareness, promoting public participation, strengthening information systems, and strengthening regional cooperation and exchange of resource information. It becomes obvious to heighten Alberta's aggregate resources to the profile they require, for establishing a balanced integrated resource management system; there is a need for collaborative governance measures that inventory and accurately monitor production and depletion rates of these resources.

Chapter 5 Calahoo/Villeneuve Case Study

Public Opposition to Resource Development

In 1975, public opposition nearly shut down all aggregate extraction operations within the Sturgeon County. These sources serve the Edmonton construction market. A provincial study initiated by Alberta Environment allowed the extraction activity to continue until 2000 when public opposition again questioned the rationale of the activity. This time, the Sturgeon County Council formed a committee with equal representation from the resource sector and public to address the concerns from both sides. Through this process an Area Structure Plan was developed and adopted. The case represents the typical situation being experienced across Alberta as residents increasingly resist the aggregate resource extraction activities.

This Chapter is an extract from a paper "*The Application of Sustainable Development Principles to the Alberta Aggregates Resource Sector*" by Jeremy Richards and the author (2004).

Background

The Calahoo/Villeneuve area in Sturgeon County is host to a resource of 154,446,000 m^3 of gravel and 572,444,000 m^3 of sand (Edwards et al., 1985), and is located approximately 40 km from the major urban centre of Edmonton (metropolitan area population >900,000; Fig. 14). Gravel pits in this area produce approximately 2 Mt/year of aggregate, approximately a third of the city's demand (ASGA, 1994).

The pre-glacial sand and gravel deposits in the Calahoo/Villeneuve area are approximately 30m-thick, and are covered by an average of 13m of glacial till and lacustrine deposits of the former Lake Edmonton (a glacially dammed lake).

Production from these deposits began in 1962, and disturbance from the operations was being felt by area residents by the early 1970s. In 1977, Alberta Environment initiated a study to address these concerns. The report, conducted by Shelley & Associates (1977), inventoried existing and planned land use, conducted a census and poll of people living within the area, and examined concepts and standards for gravel extraction, reclamation, and land development. The stated objective of the report was "to

determine the most desirable land development and reclamation concept for the Villeneuve gravel pits, taking into consideration the major environmental and social aspects of the affected area" (Shelley & Associates, 1977, p. 12).

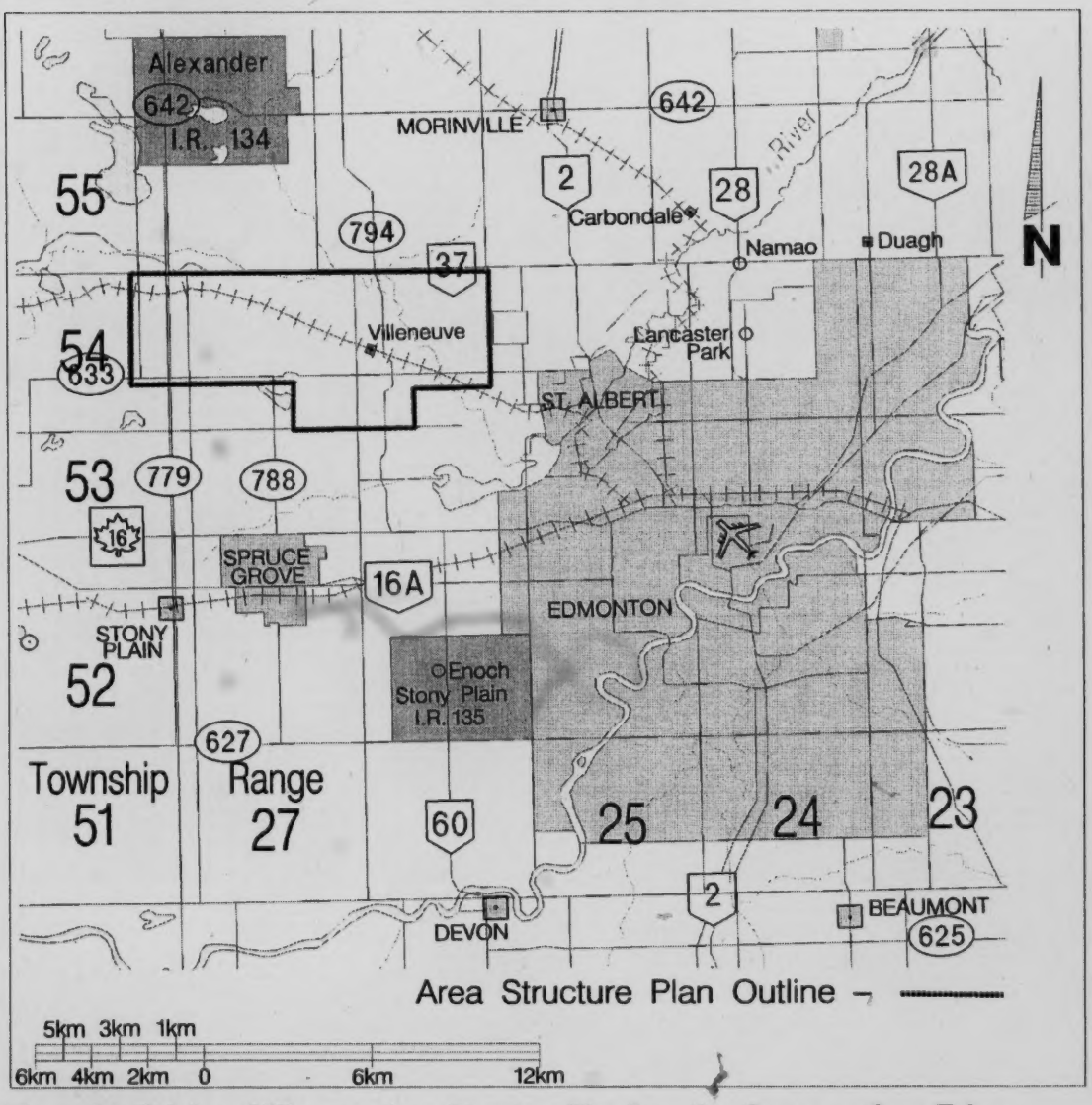

Figure 14: Calahoo- Villeneuve Area Structure Plan Location (base map from Telus Geomatics, 2002)

Shelley & Associates (1977) found that 78% of the respondents were opposed to gravel extraction operations within the area, the greatest concerns relating to degradation of road quality, safety hazards from trucking, and the lack of any direct benefits passed

on to the community from the operations. Other concerns included degradation of aesthetics, excessive noise, changes to lifestyle, and reduction of land value.

The report concluded by recommending procedures to review proposals for both resource extraction and other land use permits, and recommended identifying sand and gravel resources in order to protect them from conflicting development and land use pressures. The timing of the report coincided with the government's commissioning of the Alberta Geological Survey to conduct an aggregate resource inventory program across the province.

In several follow-up studies commencing in 1981, Alberta Environment employed the services of McElhanney Surveying and Engineering Ltd. and MLM Groundwater Engineering to develop a workable drainage plan for the Villeneuve area (McElhanney Surveying and Engineering Ltd., 1981 a–c; MLM Groundwater Engineering, 1982a,b). The plan aimed to minimize the loss of agricultural lands and to define extraction and reclamation drainage parameters for mining operations in the area (MLM Groundwater Engineering, 1982b). The survey recommended that operators should coordinate their activities, and that they should be flexible in their response to changing hydrological conditions over the course the development. Unfortunately, several of the report's recommendations were not implemented, including that of conducting a hydrological monitoring program. Nevertheless, the process did appear to relieve the conflict between the community members for a period of time.

Although Calahoo's population did not increase significantly over this period, Villeneuve's population increased from 50 (1966) to 176 (1991), and one new subdivision has been developed over the deposit since 1977. Within the general region, the number of country dwellers in Sturgeon County has risen dramatically from 379 in 1966, to 15,947 in 2001 (Shelley & Associates, 1977; Hydrogeological Consultants, 2001).

In 2000, renewed opposition to the aggregates industry in the area arose due to alleged contamination and/or loss of groundwater supplies (Norton, 2000), although these allegations were not proven. The Alberta Concerned Landowners, a local residents group, queried why a new application to extend extraction operations on to land held by an aggregate resource operator did not require an Environmental Impact Assessment, a

mandatory procedure for any other mining development in the province. In response, the Sturgeon County Council passed a motion on May 23, 2000, to draw-up an Area Structure Plan (ASP)(Sturgeon County, 2001), and assigned a Project Steering Committee to this task. The committee had a formal structure with equal representation from industry and area residents, all with voting rights. A Technical Advisory Group was also formed which included four County officials involved in planning, a representative from the Alberta Sand and Gravel Association, one Alberta Environment approvals inspector, an Alberta Environment hydrogeologist, an Alberta Municipal Affairs representative, and a representative from Alberta Transportation. The overall facilitation, reporting, and technical aspects were handled by UMA Engineering Ltd.

The Calahoo/Villeneuve ASP was subsequently adopted by Sturgeon County Council on October 9, 2001 (Fig. 15). The plan included land use zoning that identified areas permitted for resource extraction, and a groundwater protection and monitoring program (Sturgeon County, 2001). A Community Liaison Committee was struck to monitor implementation of the plan and to deal with any concerns or issues that arose between the public and industry (Sturgeon County, 2002). Funding was also put in place by the Council for the Groundwater Monitoring Program, which will monitor eight wells (initially) for water chemistry, dissolved metals, solvents, hydrocarbons, and bacterial growth.

An important outcome of the ASP was that the County was able to negotiate increased taxation revenue from the industry to cover extra administrative costs incurred by responding to public concerns, and the costs of environmental monitoring. Prior to the ASP, taxation rates for aggregate operations were based only on agricultural land-use rates.

Area residents also claimed that they should be compensated for disturbance caused by the industry. In response, the County came to an agreement with industry to set up a Community Enhancement Fund, financed through a voluntary levy of Cdn$0.125/tonne of aggregate extracted (this amount rising by Cdn$0.010/tonne each year to a maximum of Cdn$0.155/tonne in 2005; Lefebvre, 2002). The first instalment to the fund was approximately $115,000 in June 2002 and, based on an estimate of extractable reserves, it is anticipated the fund will raise a total of Cdn$11 million over the life of the extractable

part of the deposit. These monies are currently allocated to the local Athletic Association and Agricultural Society (20%), to other community groups (40%), and for county council initiated projects such as road improvements and the Groundwater Monitoring Program (40%).

Although the ASP has safeguarded access to a significant part of the Calahoo/Villeneuve deposit, it is estimated that approximately half of the total available resource, as defined by the Alberta Geological Survey (Edwards, 1984b), is off-limits for extraction. This situation appears to have resulted in part from the fact that the ASP did not take resource information into account when making land-use decisions, but instead based these decisions on land assets held by the aggregate resource sector at that time.

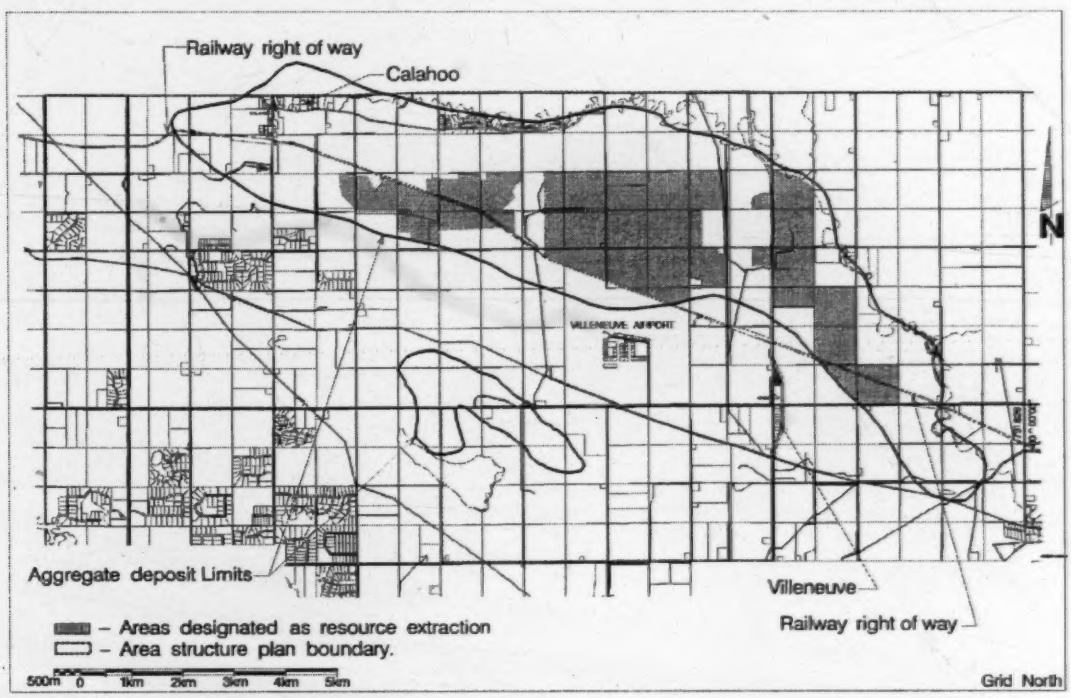

Figure 15: Calahoo-Villeneuve ASP Showing Designated Resource Extraction Areas

Implications of the ASP for Resource Development

The effects of implementation of the Calahoo/Villeneuve Area Structure Plan can best be assessed by considering the impact of its absence, and the consequent potential closure of this resource. The closest known alternative large-volume source of aggregates

in the Edmonton area is located a further 50 km from the city (Fig. 16), requiring more than double the haulage. It is estimated that haulage costs, exclusive of indirect costs such as insurance claims and highway maintenance, amount to Cdn$0.14/tonne/km (http://www.woodlands.ab.ca/works/word/RATESCH.DOC). Relocating an annual production of 2 million tonnes/year to this new more distant area would equate to an increased annual expenditure of approximately Cdn$28 million, and would add approximately Cdn$14 to the cost of a tonne of aggregate.

In addition to these economic costs, the increased haulage distance would contribute significantly to greenhouse gas emissions.

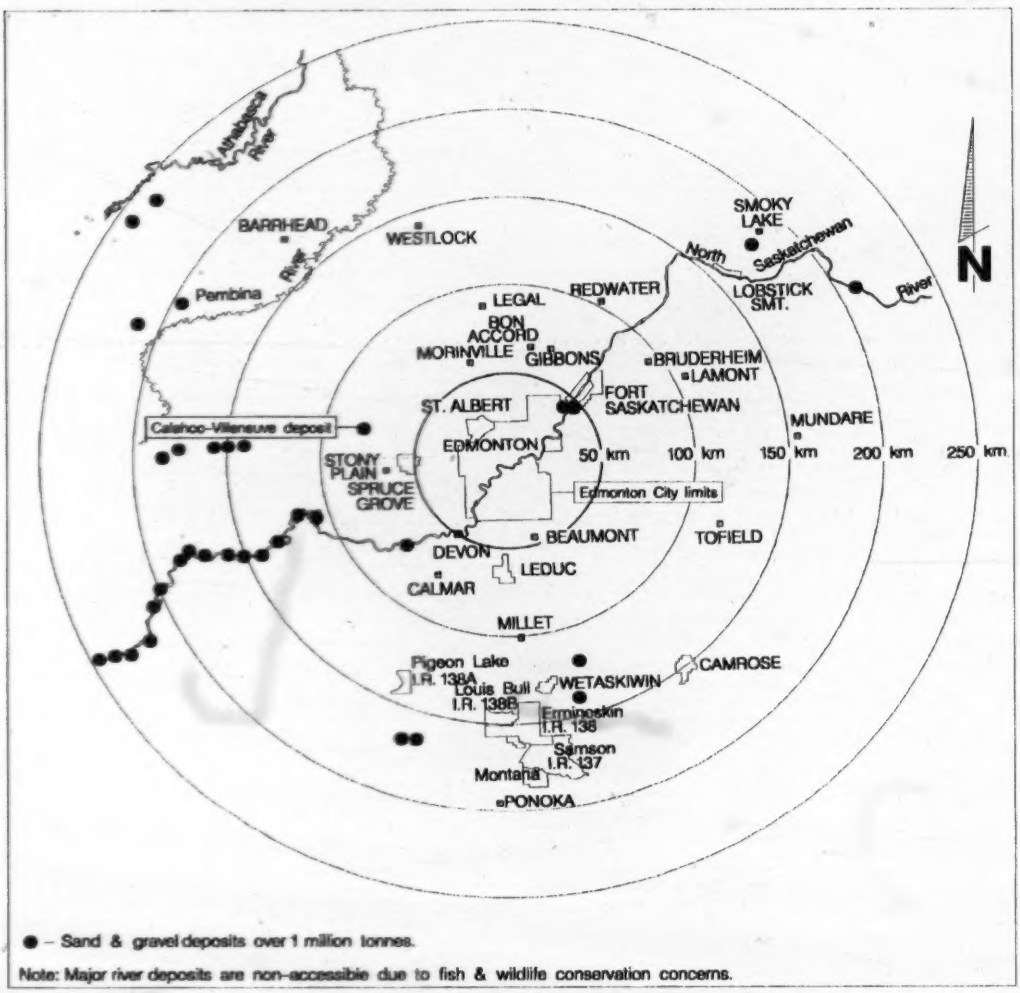

Figure 16: Major aggregate deposit locations in the Edmonton area (Edwards et al., 1985).

Typical haul trucks consume approximately 0.5 litre of diesel fuel per kilometer, and emit ~1.0 kg CO_2 per km (United Nations Environment Programs, 1996). Assuming a 34 tonne load, approximately 60,000 trips per year are required to deliver 2 million tonnes of aggregate. If this material had to be hauled from a site 50 km more distant (100 km additional round-trip distance), this would result in increased emissions of ~6,000 tonnes of CO_2 per year. Emissions of particulate matter, which have been closely linked to human health problems (OEHHA, 1998), would also increase.

Even with the ASP in place, approximately half of the available resource in the Calahoo/Villeneuve deposit will not be exploitable due to land-use restrictions (e.g., reserved for agriculture, environmental protection, and airport and subdivision development). The amount of material thus "sterilized" is estimated to be approximately 232 million tonnes. Using the above analysis, supplying this amount of material from a source 50 km more distant would produce a total of ~682,000 tonnes of additional CO_2, and cost an additional Cdn$1.6 billion in haulage costs in today's dollars. The non-exploitable portion of the deposit also equates to $45 million of lost revenue for the County.

Evaluation of the ASP in Terms of "Seven Questions to Sustainability"

In 2002, MMSD-North America (a regional division of the global Mining, Minerals and Sustainable Development project) published its report "Seven questions to sustainability: How to assess the contribution of mining and minerals activities." This report proposed the following tests that could be applied to mining activities:

1. *Engagement: Are engagement processes in place and working effectively?*
2. *People: Will people's well-being be maintained or improved?*
3. *Environment: Is the integrity of the environment assured over the long term?*
4. *Economy: Is the economic viability of the project or operation assured, and will the economy of the community and beyond be better off as a result?*
5. *Traditional and Non-market Activities: Are traditional and non-market activities in the community and surrounding area accounted for in a way that is acceptable to the local people?*
6. *Institutional Arrangements and Governance: Are rules, incentives,*

programs, and capacities in place to address project or operational consequences?

7. *Synthesis and Continuous Learning: Does a full synthesis show that the net result will be positive or negative in the long term, and will there be periodic reassessments?* (IIED, 2002c).

Although principally designed with the metallic minerals sector in mind, these tests can equally well be applied to the aggregates industry, and are a useful starting point for assessing sustainability in this sector. As an example, the ASP is evaluated below according to these questions:

1. Engagement

The ASP was developed in direct response to an urgent need to resolve conflicts between industry, land-owner, and residents groups in the Calahoo/Villeneuve area. The plan was accepted by these stakeholders, and a Community Liaison Committee continues to monitor the process. The ASP was developed uniquely by the Sturgeon County Council to fill a gap in provincial legislation, and this plan could serve as a template for agreements in other municipalities, or for the development of new provincial legislation.

2. People

The Community Enhancement Fund was set up specifically to ensure that some direct benefits from the aggregates industry flowed back to the local community. In addition, the industry's effect on community health is addressed through the Community Liaison Committee and the Groundwater Monitoring Program.

3. Environment

The report by Shelley & Associates (1977) and the ASP both provided baseline environmental impact assessments to a higher standard than those required under the provincial Environmental Protection and Enhancement Act. The ASP further assured funding for the Groundwater Monitoring Program through the Community Enhancement Fund. However, it is suggested that more attention could be paid to other environmental aspects such as waste, recycling, soil handling, landscape change, air quality, and noise. In addition, sterilization of approximately half of the total available resource will have

significant future environmental consequences resulting from haulage from more distal deposits when the Calahoo/Villeneuve deposit is exhausted.

4. Economy

Distance to market is the key economic parameter affecting the aggregates industry. By providing continued access to the Calahoo/Villeneuve deposit, the ASP has ensured an economic supply of aggregates to the Edmonton market for the next 10 to 15 years. Through the Community Enhancement Fund, the ASP has also ensured that some economic benefits accrue directly to local residents. Nevertheless, as noted above, sterilization of a significant part of the resource will mean that future supply may have to be hauled from much greater distances, at much greater cost. These costs will be passed on to consumers through increased building prices and taxes.

5. Traditional and Non-market Activities

Because aggregates have been extracted from the Calahoo/Villeneuve region since 1962, this industry might be seen as a traditional activity in the area, alongside agriculture. Certainly it pre-dates expansion of rural subdivisions within and in close proximity to the ASP area. It could be argued, therefore, that the aggregates industry has a prior claim to activity within the region when compared to new subdivision residents. Nevertheless, by clearly identifying areas in which aggregates extraction will be permitted, the ASP should serve to draw a line under these competing claims for land access.

6. Institutional Arrangements and Governance

A major drawback to the ASP is that its implementation is largely voluntary, and it is not underwritten by provincial law. No arrangements have been made for enforcement, and the process will largely rely on public input to monitor the activity. In contrast, a similar assessment process being conducted by a neighboring municipality (Lac Ste. Anne County) is proposing to include an enforcement component (Neufield, 2003). It is to be hoped that the ASP and subsequent plans developed by other municipalities will serve as starting points for improved provincial legislation.

One failing of the ASP is that it did not incorporate resource data adequately into the planning process, with the result that a large part of the resource has been sterilized for aggregate extraction. By way of comparison, the Californian Surface Mining and Reclamation Act (SMARA, 1975) mandates the California Geological Survey to generate maps and reports that will assist in the protection and development of mineral resources. Municipal agencies are given a year to include this information into their land-use plans. It is suggested that the Alberta Geological Survey's role in this regard should be revived.

7. Synthesis and Continuous Learning

The ASP has provided an agreed strategy between all stakeholders for continued exploitation of aggregate resources in the Calahoo/Villeneuve area. All stakeholders stand to win over the alternative, which would have been closure of the extraction operations. This would have affected not only the viability of the industry, but also the economy of the city of Edmonton through significantly increased prices for aggregates. Local residents stand to gain through mechanisms that will ensure their concerns are dealt with, and through direct benefits from the Community Enhancement Fund. However, in obtaining agreement, a compromise was struck that resulted in sterilization of approximately half of the aggregate resource, which is now designated as off-limits for extraction.

Although the ASP does not specifically include provisions for periodic reassessment of the process, as called for in the MMSD-North America report (2002), Shelley & Associates (1977) called for a flexible response to changing conditions during extraction operations. The willingness of stakeholders to engage in the original Area Structure Plan suggests that dialogue and evolution of the plan will continue.

Summary and Conclusions

The case history of the Calahoo/Villeneuve aggregate deposit near Edmonton, quantifies some of the economic, social, and environmental costs associated with the sterilization of the aggregate resources, by a municipal planning procedure.

Development of the Calahoo/Villeneuve deposit provides an example of the conflict of interests that commonly occurs between rural dwellers and the extractive industry. Complaints from residents arising from noise, dust, and heavy vehicle traffic, as well as

fears of groundwater and other environmental pollution, compounded by a lack of any kind of compensation, threatened to close access to these resources. Consultative action by Sturgeon County Council led to the development of an *Area Structure Plan* that established the limits of aggregate development, and implemented a number of strategies and programs to satisfy the concerns of residents and aggregate resource sector. The plan also introduced a voluntary levy on production, which are paid into a Community Enhancement Fund.

The success of the Calahoo/Villeneuve ASP has been measured against MMSD North America's (2002) Seven Questions to Sustainability, and it is shown that in general the plan was well developed and executed. However, two main shortfalls of the plan are that (a) implementation is voluntary, and (b) the Alberta Geological Survey's aggregate resource inventory for the area was not referred to when making land-use decisions, and consequently approximately half of the projected resource (approximately 232 million tonnes) is now inaccessible. The cost of sterilizing this volume of resource, and the future necessity to haul materials from more distant deposits (the next nearest large deposits are 50 km further from Edmonton) could amount to an extra Cdn$1.6 billion in haulage costs in today's dollars, with the production of ~682,000 tonnes of additional CO_2 in exhaust emissions. In addition, the County will forego approximately $45 million in contributions to the Community Enhancement Fund. Other impacts will be extra road hazards and road maintenance costs.

Overall, the ASP has made a significant contribution towards sustainable development in the Calahoo/Villeneuve area through improved governance. Further advances at a provincial level could be achieved by implementing a similar process including an aggressive aggregate resource inventory program. Orderly resource and municipal development, which includes the assessment of the aggregate resources, will significantly benefit the economy, environment, and social values.

CHAPTER 6 INDUSTRY PRACTICES

Industry Survey

A survey of aggregate sector operators was conducted as a part of this research project, with the main objective of developing an understanding of the aggregate resource sector operators in Alberta and their concerns. The survey was designed by the author and approved by the ethics board of the University of Alberta.

Most contacts were taken from the membership list of the Alberta Sand and Gravel Association. The ASGA has 127 members (ASGA, 2003) out of a possible 300 sand and gravel producers (Edwards, 1998, p.374). To get a poll from non-members, contacts were obtained through Provincial government files. Nineteen questionnaires were completed through an interview process with company representatives between March 2002 and March 2003. The questionnaire is reproduced in Appendix B and the survey results are tabulated in Appendix C.

Sector representatives in the Edmonton area, Slave Lake, Ft. McMurray, and Calgary were interviewed. Appendix C categorizes the respondents into producers, processors, producers/processors, and consultants, and documents the range of company size and length of time operating. The representation appears to cover a good variation from grass roots operators attempting to enter the business to long time operators, from small operators to multinationals, and from different regions of Alberta. The time taken to complete each survey varied from 30 minutes to over 3 hours with an average of 45 minutes.

The respondents are categorized as:

- Producer (16% of survey population): supplier of pit-run material from resource extraction sites;
- Processor (10% of survey population): obtains aggregate resources through a producer, producer/processor, or both to process the aggregate to meet the specifications for various applications and does not operate a resource extraction site.
- Producer/Processor (53% of the survey population): operates supply source and processes material to product specifications;

- Consultant (21% of the survey population): contracted by a producer or producer/processor to handle the approval processes required at the federal, provincial, and municipal levels.

Eighty seven percent (87%) of survey respondents, excluding the consultants, use consultants for various aspects of the operations. With the continued strong economic conditions in Alberta the majority of the respondents (15 out of 19) anticipated an increase in land acquisition, equipment, or manpower. The survey respondents represent companies that produced 48% of Alberta's production total as reported by Statistic Canada for 2001 (21,507,699 tonnes out of a total of 44,692,000 tonnes), from 2% of the pits (118 out of a total of 5962 pits).

As the survey was conducted it became apparent that of the 49 questions asked, some questions were difficult to answer (e.g., #17: areas where respondents spent their time), some were not beneficial from a statistical point of view because the categories were not formulated to capture consistent and meaningful numerical data (e.g., #15: Capital investment categories require a specific accounting assessment in cases where companies have multiple business functions), and other questions got a wide variation of answers (e.g., #6: products produced).

Survey Summary

A summary of the results (Appendix C) of the survey is given below and the correlation between producer/processors, producers, processors, and consultants are shown in Table 14:

Table 14: Industry Survey Highlights

	Producer /Processor	Producer	Processor	Consultant
Number Surveyed	10	3	2	4
Range in Years of Operation	0-68	4-57	36-38	3-50
Average Years of Operation	28	37	37	16.5
Range Employee #s	2-200	2	3-2550	1-4
Average Employee #s	27	2	1276.5	2.75
# of Pits (Private Land)	62	23	0	0
# of Pits (Public Land)	30	2	0	0
Range in production	0-6,000,000	40,000-250,000	100,000-130,000	
Production (tonnes 2001)	18,280,000	2,997,699	230,000	
Expenditure per Approval ($)	56,000	32,500	22,500	
Haul rate (t/km/yr)	663,988	14,500	13,667	
CO_2 emissions (associated to resource hauling distance-kg/yr)	19,529	426	401	
Capital investment (category*)	1-5*	1-2*	4*	
Use Conservation & Reclamation plan as operating directive	100%	67%	100%	

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million.

Alberta's Resource Developers

- Alberta has several experienced resource developers (operators) that have an average of 28.6 years of operation in the aggregate resource extraction industry;
- The aggregate resource sector companies (excluding consultants) employ an average of 29 people per company;
- The respondents have pits an average of 34 km from the market;
- The aggregate sector has difficulty competing with the oil/gas and forestry sectors to attract experienced employees. The aggregate sector does not match the wage benefits offered by the other resource sectors;
- Most aggregate resource developers are planning to make additional investments in land, equipment, and/or manpower within the next 5 years;

- The average aggregate resource reserve held by producers is 32 years, and most operators are conducting exploration programs ranging from $2,000 to $100,000 annually to increase their reserves;
- The overall consensus is that there has been an increase in the competition level between the resource developers;
- The biggest challenges related to aggregate production are:
    - cost of operating (capital, attracting and retaining employees, meeting shareholder's demands),
    - cumbersome approval processes (meeting demands of the variety of approval requirements, costly report requirements, government contacts hard to connect with and change frequently, government bureaucracy),
    - small to medium sized companies are finding it harder to compete with multi-national companies,
    - achieving aggressive progressive reclamation (sequencing pit reclamation to follow as soon as the resource is depleted one area while developing the next area),
    - lack of newly discovered or accessible aggregate sources,
    - opposition by residents and local landowners,
    - meeting product specifications that create high reject volumes,
    - finding aggregate sources to meet specification requirements,
    - haul routes becoming restrictive,
    - unfavorable public image,
    - marketing the resources.
- Most developers feel they are employing sustainable development practices in their operations through:
    - reclamation,
    - progressive reclamation,
    - recycling (concrete and asphalt),
    - full resource utilization,
    - minimized haul,
    - balancing between social, environment, and economic needs,

- following the regulations,
- assessment of aggregate deposit in light of market needs to ensure the resource is maximized,
- topsoil salvage,
- orderly development (planning) integrated with resource use, to minimize resource sterilization,
- ongoing supply of raw materials through profitable business opportunities for private investors,
- finding alternatives to depleting resources,

Sector's View of Governance

- The sector is not over regulated. Developers perceive 77% of the operators are in compliance with the regulations, and only 3 respondents felt that operators not complying to the regulations were affecting the competition level. However, half of the respondents suggested a need for better enforcement in response to Question 44 (requirement to create a level playing field for operators);
- The time it takes to obtain an operating approval averages 1.2 years. The approval process for private land is perceived as the most efficient of the two provincial approval processes; however, the timing period is not acceptable to the aggregate resource sector;
- All but three respondents found the government's Conservation and Reclamation Plan requirement a beneficial tool to design and guide pit development;
- 60% of the respondents opposed adoption of the government's "code of practice for pits" (private land);
- All but two operators have pit developments associated with water resources;
- Only 6 of the 15 operators have knowledge of whether their company responds to the Federal production survey. Five of the developers who did not provide production statistics together produced 12,807,669 tonnes of aggregate in 2001. Most respondents did not have an opinion on the accuracy of the federal statistics. Of the respondents who voiced an opinion, four suggested that the production

figures are "not accurate" and one respondent felt the federal statistics may be "somewhat accurate";

- All the major producers use professional assistance for designing their pit development plans, which is included in the cost of obtaining an approval. The average cost to obtain an approval is $43,000;
- Respondents unanimously favored government protection of access to aggregate resources from conflicting land uses, through:
    - the adoption of an unbiased review board in approval disputes,
    - provincial government support for pit development and intervention in conflict situations,
    - the inventory of potential aggregate extraction areas in conjunction with the land use/conservation planning processes to maintain access to these sources,
    - provincial/municipal regulation on any development, which potentially affects access to aggregate resource extraction, by requiring a subsurface assessment to ensure extractable aggregate resources will not be affected,
    - provincial government regulation to ensure that the aggregate resources are developed to their maximum potential (prevent high grading),
    - educating Energy Utilities Board staff of aggregate resource value,
    - mandating a government body to protect resource,
    - switching from private pit operations to the public pit system,
    - compensating people directly affected by pit operations,
    - educating political leaders of the necessity to develop the aggregate resources in face of public opposition.

Sector's View of Alberta Sand and Gravel Association's Effectiveness

- 68% of the respondents felt the ASGA was effectively representing their interests, 10% felt the ASGA was not effective, 11% could not evaluate the organization, and 11% had no comment.

- Suggestions for increasing the ASGA's effectiveness included:
  - Hiring full time paid staff to deal with the sector's issues (a billion dollar industry should be able to support dedicated professional staff),
  - That ASGA become more pro-active instead of responding to problems,
  - Increased public relations,
  - That ASGA develop effective operating standards and licence companies who have the ability to operate accordingly.

Additional Input

- Educate the public of the advantage of a planning process that ensures development of aggregate resources prior to any other development that would restrict future access to the resources,
- Developers should be more responsive to public complaints,
- The sector has seen positive developments related to recognition of the sector's importance, and developers must take the initiative to be involved in changing the regulatory framework,
- Better royalty monitoring,
- The red tape for operating in Alberta is increasing,
- Design a fast approval process with an appropriate financial security requirement that would cover all potential liabilities,
- The resource development's contribution to the greater good for Alberta has to be promoted to the public by government,
- Gravel bars within rivers should be accessible by developers,
- Follow the British Columbia Geological Survey's practice of releasing resource information to public,
- Aboriginal input should be initiated in the approval process,
- Political influence should be minimized in resource decisions,
- Developers with a reputation for good business practices should be given preference in the approval process (less requirements for documenting operational design),

- Land use decisions must be scientifically proven (municipal decision makers not equipped to employ qualified professionals for proper review of applications),
- There is a need for a central licencing agency for resource developers.

Survey Overview

Although the industry survey only represents 15% of ASGA's membership and 6% of the possible total of aggregate resource companies in the province, the respondents interviewed represent companies that produced 48% of Alberta's 2001 total production. Therefore, the information collected should be broadly representative of the sector's perspective.

The survey itself had data collection flaws, mainly due to the wording of the questions asked and the manner in which the survey was conducted. Question 30 is an example of indirect wording as the question does not specifically ask if the respondent is in favor of the "codes of practice", which was the intent of the question. Therefore the resulting data suggesting that 60% are in opposition to the "Codes" may not be representative. Many responses were estimations without statistical data, because the survey was conducted usually without the respondent having time to obtain accurate information. To address the accuracy of data, the respondents could have been asked to fill out the questionnaire prior to the interview.

Overall, the survey can be treated as a beneficial portion of the research program as the interview process did allow the author the opportunity to obtain an undistorted view of each interviewee's perspective of the issues facing the aggregate resource sector. More significantly, the process heightened the ASGA profile, because a segment of the membership had an opportunity to provide personal input. More time should have been devoted in this area to reach a higher percentage of the membership. Generally, the survey concludes the membership support employing improved operational practices to gain credibility with the public sector as long as all the operators are monitored and enforced under regulation that takes into the consideration the scale and impact of the operations. There are also many opportunities for the aggregate resource sector to become recognized as a significant contributor towards sustainable development. Firstly, to obtain a consistent national standard practices, the ASGA could consider closer

working ties to other provincial producer associations (e.g. Aggregate Producers Association of British Columbia, Aggregate Producers of Ontario). Secondly, to obtain recognition as a significant contributor towards sustainable development, ensure the aggregate production sector is well represented in all mining sector initiatives related to sustainable development practices.

Alberta Sand and Gravel Association (ASGA)

The ASGA represents a membership of Alberta resource developers and consultants who service the sector. The organization was formed in 1975 in response to the first organized public opposition of the extraction activity in the Calahoo/Villenueve area (Sturgeon County). The organization proved to be successful inasmuch as the Calahoo/Villenueve operations were allowed to continue, in the face of political opposition. The membership originally consisted of the major companies involved in Sturgeon County. Membership expanded to include "mom and pop" operations. The organization grew to over 100 members by 1996 through an aggressive membership drive started in 1995, sparked by pro-active leadership (John Moquin of Inland Aggregates Limited). From 1992-1996 the ASGA had representation on Alberta Environment's Sand and Gravel Task Force where the "*Guide for Pits*" was developed. The ASGA also became a member of the Alberta Chamber of Resources in 1995. Also in 1995, the ASGA became very active through the formation of the Sand and Gravel Direct Action Team (SAGDAT) and the Sand and Gravel Industry Stakeholders Committee. Both committees, along with the aggregate sector representation, had representation from all the government agencies dealing with aggregate resources, with the exception of the Alberta Geological Survey. SAGDAT's objective was "*to work co-operatively to resolve issues related to the ordinary, operational management and administration of sand and gravel resources*" (SADGAT, 1995 p.5). SAGDAT tabled 45 issues to be dealt with. The Stakeholders Committee had senior management representation and was designed to promote policy making and legislative changes that would assist the sector to operate effectively.

The Stakeholders Committee met very irregularly and eventually dissolved in 2000. SAGDAT successfully dealt with 3 of the 45 issued tabled and was actively dealing with the balance until the committee lost its momentum during the year (2000) because of high construction activity. The committee has not been active since.

The Sturgeon County's public opposition to the Calahoo/Villenueve extraction operations in 2000 forced the ASGA to enlist the assistance of the Alberta Roadbuilders and Heavy Construction Association (ARHCA) jointly to address the situation. Through this alliance, they lobbied the provincial government (Department of Municipal Affairs) to form the Sand and Gravel Task Force, to address the municipal approval process.

Alberta Chamber of Resources

The Alberta and North West Chamber of Mines and Resources initially started out in 1935 as a liaison between the hard-rock mining industry of the north and the service industry. They are now known as the Alberta Chamber of Resources (ACR). The Chamber has evolved into a group of resource developers of different sectors, joining forces to find ways to improve their performance as resource stewards, and to proactively meet government regulation objectives. Recently, the ACR has partnered with the University of Alberta to conduct research towards lessening the footprint of industry on the land through coordinated resource extraction by the different resource sectors (timber, oil and gas, industrial minerals, oil sands, and coal). The ACR is promoting the use of ALCES (A Landscape Cumulative Effects Simulator), a "*simulation tool for exploring the consequences of different landuse strategies and conducting cumulative effects assessment*" (Forem Technologies, 2001). The ARC has allocated $4.5 million to the Integrated Landscape Management program. This program "represents the first large scale Canadian effort to proactively address the cumulative impacts of resource-based land use" (ARC, 2003).

For the aggregate resource industry to be included in this process, inventory information and regional production figures are required for input.

Other Opportunities for the Aggregate Resource Sector

The Mining Association of Canada is actively engaged in heightening the mining profile in Canada, and the Global Mining Initiative has acted to include mineral resources in the UN's sustainable development program. The Canadian Institute of Mining, Metallurgy and Petroleum (CIM) is another organization that claims to be "*the leading technical society of professionals associated with the Canadian minerals and materials industry, has 11,000 members from industry, government and academia who are dedicated to the discovery, production, utilization and economics of minerals, metals and petroleum*" (CIM, 2002). The CIM's May 2004 conference in Edmonton highlighted sustainability of the mining community in the technical sessions. A more international organization focusing in on the concept of sustainable development for the mining sector is the International Council on Mining and Metals (ICMM).

Supporting research initiatives related to the aggregate resource sector and tapping into the research being carried out by these organizations could be a strategy that gains credibility for the aggregate resource sector.

Summary and Conclusions

The Alberta aggregate resource sector is made up of a broad spectrum of operators ranging from individuals to multi-national organizations. Therefore, industry practices ranging from site assessment, resource development planning, to reclamation techniques are equally as variable. As the sector has all the similarities of other mining activities, and the survey indicating professionals are being employed for site assessments, design pit developments, and reclamation solutions, would suggest there is an opportunity to engage the mining engineering and geological disciplines.

The survey discloses a sector of experienced operators, however there is a feeling by the experienced operators that their investment in capital and environmental diligence can be undermined by inexperienced operators or companies attempting to function with borderline financial resources or business ethics. This is a result of small operations (under 5 hectares-private land; 5 acres-public land) not being subject to the same regulatory demands of the larger pits and where the smaller operations are not developed

in an orderly fashion. These operations, can create a public image that can impact resource development proposals or operations of the compliant operators.

Environmental restrictions and land use zoning are increasing the operational costs for the sector, forcing smaller operators to find methods cost effective methods. In many cases this equates to little site evaluation, planning procedures, or contravening regulatory conditions. Most professional operators are demanding a "*level playing field*" so they can compete in the market place. In most cases, this requires better enforcement of all operations. Due to regulatory priorities, many operations are not being conducted in a manner that would be welcomed from a public perspective. Most operators are willing to employ better operational practices to address environmental concerns and better reclamation results, however there must be an improved enforcement component to ensure all operators are employing the more costly measures.

The ASGA is improving its role in providing a voice for Alberta aggregate producers, processors, and their consultants by collaborating with organizations such as Alberta Roadbuilders and Heavy Construction Association, and Alberta Chamber of Resources. However, there is still a need for a national consistency and to bring the sector profile to the height it deserves. This could be accomplished by increasing the awareness of the sector's profile to other mining professionals through sector members participating in organizations such as CIM, MAC or the ICMM. The ASGA could also consider spearheading the formation of a nation organization similar to the United States' National Stone, Sand & Gravel Association with a mission to heighten the sector's profile and create consistent national-wide standards for the industry.

Chapter 7 Conclusions

Sustainable Development

Humans possess a unique ability to utilize the Earth's resources in many creative ways. However, this ability appears to be affecting the Earth's capacity to sustain human development and rising population, as these trends heighten demand for natural resources. Our indulgence in a technologically-assisted life-style also appears to be distancing human awareness from environmental consequences of this life-style. In contrast, indigenous cultures, who stay connected to traditional values, appear to have an innate ability to interact with their environment in a sustaining manner. Many of their rituals heighten their awareness to respect and preserve the ecosystems in which they live.

To reconnect the industrial-developed cultures and keep developing cultures connected with environmental values, the United Nations introduced and is building on the concept of sustainable development. This concept is guided by Rio Declaration on Environment and Development's 27 principles (UNEP, 1992). Sustainable development, as prescribed by the United Nations, is a holistic approach to regulate human interaction between nations and with the Earth to establish a new and equitable global partnership and ensure a healthy environment for future generations (UNEP, 1992). The United Nations' Agenda 21 outlines policies and program requirements for achieving a balance between consumption, population, and the Earth's life-supporting capacity.

According to Agenda 21, governance plays an important role in achieving sustainable development by focusing on:

- *developing supportive policies and policy instruments,*
- *strengthening planning and management systems,*
- *promoting application of appropriate tools for planning and management,*
- *raising awareness,*
- *promoting public participation,*
- *strengthening information systems, and*
- *strengthening regional cooperation and exchange of information on land resources* (United Nations Sustainable Development, 1992, Sections 10.6 to 10.12).

Under these items, technology development becomes a key to bridging the growing gap between human needs and the Earth's capacity to support life. Because sustainable

development is a multi-faceted concept, the merging of the expertise of many disciplines is essential in developing technical solutions.

Already, a wealth of initiatives has been and is being carried out in response to the concept of sustainable development by governments, industry, academia, and aboriginal groups. Initiatives involving indigenous people are likely prime development areas, because aboriginal knowledge and traditional practices are recognized as a key to sustainable development (Principle 22 - Rio Declaration). Also, to effectively employ technological advancements or focus research efforts, priority should be given to resources being rapidly consumed by the global society.

Sustainable Development of Mineral Resources

Non-renewable minerals constitute a large portion of the natural resources used by humans. According to World Summit On Sustainable Development (WWSD), minerals are deemed as "*essential to modern living*", therefore, "*enhancing the contribution of mining, minerals and metals to sustainable development*" is part of the "Johannesburg Plan of Implementation" (WWSD, 2003, paragraph 46). This recognition, by the United Nation's action guide to sustainable development, may be a result of the mining sector's efforts through the Global Mining Initiative, the MMSD project, the Whitehorse Mining Initiative, etc. From this point it appears the interests of the mining sector will be addressed through the World Mines Ministries Forum (WMMF, 2004) and the Global Dialogue of Governments on Mining/Metals and Sustainable Development (GDGMSD, 2004). It could be then argued, the best areas of focus for these initiatives would be associated with minerals having high consumption rates, essential to social need, and pose an environmental risk. As these are the characteristics of the aggregate resources sector, representatives from the sector should be heavily involved.

The Role of Geoscience in Sustainable Development

Agenda 21 devotes a chapter identifying actions the "*role and the use of the sciences in supporting the prudent management of the environment and development for the daily survival and future development of humanity*" (UNCED, 1992, Chapter 35). Also, a chapter identifies the need for improving communications and cooperation between the scientific community, decision makers and public (UNCED, 1992, Chapter 31). Here's

where geoscientists, involved in mining activities along with their understanding of Earth dynamics, become positioned to provide a leadership role for initiating research for practical applications. To carry out this role requires someone to champion innovative collaborations among the different disciplines. Thus, universities become prime sources for providing the necessary development protocol and network opportunities. However, this will only materialize if the mining sector and governments support the role through appropriate funding and partnership policies.

By virtue of the ease with which surficial sand and gravel deposits have been found and developed, little scientific involvement has been employed. Due to resource depletion of known sources, continued demand, and environmental considerations, approaches involving detailed geologic assessments and interpretations are becoming a necessity. The lack of related expertise provides geoscientists with an opportunity to contribute to enhancing the mining sector's contributions to sustainable development by concentrating on aggregate resources as a key area of focus. Again it is up to aggregate resource sector representatives to initiate and back research efforts that convey how the sector contributes to sustainable development.

Mineral Aggregate Resources Relationship to Sustainable Development

Global mineral commodity production figures reveal society's heavy reliance on aggregate resources. Paradoxically, aggregate resources have virtually been taken for granted in many parts of the world, including Canada. This could be due to the perceived unlimited supply of aggregates, the lack of scientific involvement in locating and extracting these resources, and the low value these resources attract. Most geoscientists are drawn to the more geologically exotic minerals such as gold, and recently, diamonds. These exotic minerals also capture the public's attention. Therefore, aggregate resource mining appears to be treated as less significance compared to other mineral mining activities, and aggregate producers are usually not included as part of the "mining community". Although this segregation and lack of attention has allowed the aggregate sector to escape some rigid regulatory requirements, a number of concerns, which impact the path to sustainable development are becoming evident.

There is evidence that the aggregate resource sector is not accurately measured from the production perspective. A study by the Alberta Geological Survey (AGS), suggests Alberta production rates are under-reported. If this occurs at the national level, the true economic significance for the resource is not being captured. As well, the economic consequences of not identifying and protecting access to aggregate resources are not factored into land use decisions. These factors, combined with the rapid increase in cost (f.o.b.) for the aggregate itself (with Alberta experiencing the highest Canadian rise in value between 1995 and 2001 at 44%) will ultimately affect construction costs.

Constructing adequate roadway networks and keeping them well maintained consumes the largest portion of aggregate resource production, and this activity could be referred to as "paving the way to economic success". Public construction and maintenance projects, therefore, require heavy expenditures of taxpayer dollars, to the point where governments are seeking new ways to fund these growing needs and recurrent costs (i.e., deteriorating infrastructure).

From an environmental perspective, most aggregate mining approvals do not require such rigid environmental assessment standards or receive the same regulatory scrutiny, as other mining activities. Due to the volumes of aggregate resources being consumed and transported, rising environmental concerns are associated with land disturbance, greenhouse gas and particulate emissions, and exposure or removal of the medium (sand and gravel) that may be associated with water resources.

Social considerations will also command more attention, because the public at large is increasingly opposed to resource extraction activities. This is a result of not inventorying and protecting access to aggregate resources prior to community or industrial development. Canadian provinces, with the exception of Ontario, do not appear to have legislation or policy that identifies and incorporates aggregate resources into an integrated resource management process. Ontario alone has adopted California's legislative format of integrating aggregate resource inventory information, garnered by their state geological survey, into the planning process.

Highlighting the magnitude of social significance that the aggregate resource sector holds, is the first step to purposefully engaging the geoscience and governance communities. The public also has to be educated on the importance of the resource.

Aggregate resource developers have an important role in gaining recognition as good community neighbors, which can be accomplished through improved operating standards. Detailed site assessments, orderly development and reclamation planning, and researching and employing innovative techniques that minimize any environmental impact, are areas of opportunity. Small or inexperienced developers, who have fewer resources to direct towards these costly processes or have not yet developed the skills for running an efficient environmentally friendly operation, should be operating only where environmental risks and interaction with public are low. Aggregate resource extraction should be governed by the same criteria as any other mining activity. This could be accomplished by aggregate resource developers directing more effort into research and development initiatives, and becoming well represented in organizations like ICMM, CIM, and ARC for sharing newly developed innovative methods and keeping abreast of advancements in the mining community.

Finally, governance is a key area that can initiate practices that promote sustainable development, such as common standards and processes among the various levels of government, who regulate resource extraction activities.

The Mineral Aggregate Industry in Alberta

It has been estimated 5 billion tonnes of aggregate resources will be consumed in Alberta between 2000 and 2050. Although environmental restrictions mean that most fluvial deposit mining operations will have to be phased out, the continental glaciations have left Alberta with ample alternative supplies of aggregate resources. However, the depletion rate of near-market resources is accelerating as other forms of development and conservation restrict access to deposits. Location of the sources, in relationship to the market, becomes a key factor in economic, social, and environmental considerations. The distance aggregate resources have to be transported directly affects economics. Increasing fuel costs will compound the distance factor. Noise, dust, and truck traffic becomes socially opposed activities, as expanding subdivisions encroach towards mining activities. Environmentally, the longer haul distances are contributing to greenhouse gas and particulate emissions. With most primary aggregate sources being associated with valuable water resources, in combination with the Alberta government committing to a

management strategy for the province's water resources (estimated expenditure of $916 million over the next 10 years), meeting the aggregate resource demand in an economical, environmental, and sociably acceptable manner is becoming a bigger challenge for suppliers. More significantly, the biggest challenge will be placed on governing bodies to manage the resources in a sustainable manner.

To assist in this resource management challenge, aggregate resources should be recognized and given management priority equal to the resource's uniqueness and overall importance to the welfare of Albertans. The first step in resource management becomes determining the location and amount of resources available for extraction. In response to the first conflict between the resource extraction industry and community members of the Villenueve area, the Shelly report recommended that a provincial inventory should be conducted (Shelley, 1977, p.269). This study may have led to the Alberta Geological Survey's (AGS) Aggregate Resource Mapping Program in 1976.

According to a recent study by Hemmera (2004), this mapping program, conducted at the Level 3 detail, is shown to be the most effective method for identifying areas of aggregate resource potential. However, only 18% of Alberta is mapped at this level, the mapping that exists is outdated, and the resource potential information seldom finds its way into planning processes. A prime example is the Callahoo/Villenueve Area Structure Plan (ASP), which determined the resource potential through land ownership holdings (land titles held by resource developers).

The success of the Calahoo/Villeneuve ASP has been measured against MMSD North America's (2002) Seven Questions to Sustainability, and it is shown that, in general, the plan was well developed and executed. However, two main shortfalls become evident through the assessment. Firstly, implementation is voluntary, and secondly, the AGS's aggregate resource inventory for the area was not incorporated into the development of land-use designations. As a consequence of not considering the inventory data, approximately half of the projected resource (~232 million tonnes) is now inaccessible. It is estimated that the effect of sterilizing this volume of resource on future costs of hauling materials from more distant deposits (the next nearest large deposits are 50 km further from Edmonton) could amount to Cdn$1.6 billion in today's dollars (fuel cost at $0.55/l), with the production of ~682,000 tonnes of additional CO_2 in exhaust emissions.

In addition, the County will forego approximately $45 million in contributions to the Community Enhancement Fund. Other impacts will be extra road hazards and road maintenance costs.

Examination of the Calahoo/Villeneuve ASP illustrates the economic and environmental impacts associated with aggregate resources and reveals that it has made a significant contribution towards sustainable development in the Calahoo/Villeneuve area, through improved governance. The positive outcomes include a cooperative engagement of industry, public and government representatives, a cumulative assessment of the mining activities, and resources to monitor groundwater and provide community enhancements. Considering that these figures apply to only one deposit, significant gains towards sustainability would be achieved if this approach was followed at a provincial scale. Further advances at a provincial level could be achieved by implementing an aggressive aggregate resource inventory program, the data from which would be included in all land use decisions.

The Alberta government's current focus has the AGS considering merging its aggregate resource mapping function into the surficial geology mapping program, largely due to the lack of continued support from the traditional program supporters, the departments of Alberta Transportation and Sustainable Resource Development. This move may diminish the provincial government's commitment to one of Agenda 21's sustainable development practices, integrated resource management (IRM). The IRM process requires accurate, up-to-date inventory data. However, variable provincial resource data-capture and management directives, by different departments (Environment, Sustainable Resource Development, Transportation, Energy, and the Alberta Geological Survey), are the result of Alberta's silence in legislation towards the aggregate resources.

Similarly, on public land, the lack of recognition by the statutes is reflected in Sustainable Resource Development's Business Plan 2003-2006 (Alberta Government, 2004). The Plan highlights forests, fish and wildlife, and rangeland management, but aggregate resource management is de-emphasized by being included under "land use disposition management" (Alberta Government, 2004). Considering that the demand for

aggregate resources will increasingly be met from public lands, where other development and conservation initiatives are reducing opportunities for resource extraction, aggregate resources should be receiving a level of management comparable to their potential contribution to the economy.

To implement an effective resource management role, the existing aggregate resource inventory program can be enhanced through a shared, collaborative process, designed and committed to by all the government agencies involved with planning or resource management roles. The program could then employ the latest technological advances to receive and store data from the multitudes of subsurface assessments being carried out by a wide variety of activities (e.g., pipeline right of way evaluations, pipeline construction ditches, seismic bore-hole logs, soil assessments, etc.). Mapping of sand and gravel deposits as they are extracted would likely lead to a better understanding of paleo-depositional environments and, as a result, provide new exploration targets. New targets may also result from applying evolving historical climate change data to existing geological interpretations. To keep the inventory updated, the volume usage data from the pit approval reporting could be subtracted from the regional reserve figures.

Once the provincial government has successfully established an aggregate resource inventory protocol, the next step would be to develop policy to incorporate the information into all planning processes. A way to achieve this path is through a provincial strategy towards the management of aggregate resources, which has been recommended by Alberta Energy's *Alberta Mineral Development Strategy 2002* (Alberta Government, 2002c, p.23). Through such a strategy development, likely all of the activities, listed by Agenda 21, for proper governance will be employed. From that point on, mineral aggregates will become recognized for their potential contribution towards sustainable development.

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Appendix A

RIO DECLARATION ON ENVIRONMENT AND DEVELOPMENT

The United Nations Conference on Environment and Development,

Having met at Rio de Janeiro from 3 to 14 June 1992,

Reaffirming the Declaration of the United Nations Conference on the Human Environment, adopted at Stockholm on 16 June 1972, and seeking to build upon it,

With the goal of establishing a new and equitable global partnership through the creation of new levels of cooperation among States, key sectors of societies and people,

Working towards international agreements which respect the interests of all and protect the integrity of the global environmental and developmental system,

Recognizing the integral and interdependent nature of the Earth, our home,

Proclaims that:

Principle 1

Human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature.

Principle 2

States have, in accordance with the Charter of the United Nations and the principles of international law, the sovereign right to exploit their own resources pursuant to their own environmental and developmental policies, and the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction.

Principle 3

The right to development must be fulfilled so as to equitably meet developmental and environmental needs of present and future generations.

Principle 4

In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it.

Principle 5

All States and all people shall cooperate in the essential task of eradicating poverty as an indispensable requirement for sustainable development, in order to decrease the disparities in standards of living and better meet the needs of the majority of the people of the world.

Principle 6

The special situation and needs of developing countries, particularly the least developed and those most environmentally vulnerable, shall be given special priority. International actions in the field of environment and development should also address the interests and needs of all countries.

Principle 7

States shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit of sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command.

Principle 8

To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies.

Principle 9

States should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies.

Principle 10

Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided.

Principle 11

States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply. Standards applied by some countries may be inappropriate and of unwarranted economic and social cost to other countries, in particular developing countries.

Principle 12

States should cooperate to promote a supportive and open international economic system that would lead to economic growth and sustainable development in all countries, to better address the problems of environmental degradation. Trade policy measures for environmental purposes should not constitute a means of arbitrary or unjustifiable discrimination or a disguised restriction on international trade. Unilateral actions to deal with environmental challenges outside the jurisdiction of the importing country should be avoided. Environmental measures addressing transboundary or global environmental problems should, as far as possible, be based on an international consensus.

Principle 13

States shall develop national law regarding liability and compensation for the victims of pollution and other environmental damage. States shall also cooperate in an expeditious and more determined manner to develop further international law regarding liability and compensation for adverse effects of environmental damage caused by activities within their jurisdiction or control to areas beyond their jurisdiction.

Principle 14

States should effectively cooperate to discourage or prevent the relocation and transfer to other States of any activities and substances that cause severe environmental degradation or are found to be harmful to human health.

Principle 15

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

Principle 16

National authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.

Principle 17

Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority.

Principle 18

States shall immediately notify other States of any natural disasters or other emergencies that are likely to produce sudden harmful effects on the environment of those States. Every effort shall be made by the international community to help States so afflicted.

Principle 19

States shall provide prior and timely notification and relevant information to potentially affected States on activities that may have a significant adverse transboundary environmental effect and shall consult with those States at an early stage and in good faith.

Principle 20

Women have a vital role in environmental management and development. Their full participation is therefore essential to achieve sustainable development.

Principle 21

The creativity, ideals and courage of the youth of the world should be mobilized to forge a global partnership in order to achieve sustainable development and ensure a better future for all.

Principle 22

Indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional practices. States should recognize and duly support their identity, culture and interests and enable their effective participation in the achievement of sustainable development.

Principle 23

The environment and natural resources of people under oppression, domination and occupation shall be protected.

Principle 24

Warfare is inherently destructive of sustainable development. States shall therefore respect international law providing protection for the environment in times of armed conflict and cooperate in its further development, as necessary.

Principle 25

Peace, development and environmental protection are interdependent and indivisible.

Principle 26

States shall resolve all their environmental disputes peacefully and by appropriate means in accordance with the Charter of the United Nations.

Principle 27

States and people shall cooperate in good faith and in a spirit of partnership in the fulfilment of the principles embodied in this Declaration and in the further development of international law in the field of sustainable development.

Appendix B

Industry Survey 02/03/05

Five billion tonnes of aggregate will be required for Alberta's infrastructure over the next fifty years. The Aggregate Industry has the challenge to meet this demand while faced with increasing public opposition and environmental constraints for extraction operations. The following questions are aimed to obtain an understanding of how the Aggregate Industry is preparing to meet the challenge. Your input will not be associated with personal or company identity. Results of the survey will be disclosed at the Alberta Sand and Gravel Association's 2003 General Annual Meeting.

Questions

1. Your company is primarily
an aggregate producer Yes No
a construction contractor Yes No
other _____

2. How long has the company been operating as an aggregate producer?
_____

3. How long have you been with the company? _____

4. How many people does the company employ? _____, for the aggregate operations? _____

5. How many pit operations does your company have in Alberta? _____, Canada? _____, International? _____

6. Name the products your company produce from sand and gravel.
_____
_____

7. Does your company produce aggregate from crushed stone (bedrock)? Yes No

8, If yes what percentage is that of your annual production is crushed stone? _____

9. Do you predict the production of crushed rock to increase? Yes No

10. What product is in most demand? _____

11. Who are your main clients? _____

12. What was your annual consumption of sand and gravel in 2001? _____

13. What are your longest haul distances? _____

14. What is your average haul distance? _____

15. What amount of capital do you have tied up in pit development and gravel production equipment?
Under $100,000, between $100,000 and $500,000, between $500,000 and $1 million, between $1 m and $2 m, between $2 m and $5m, over $5m.

16. What is your role in this organization?
Management, Equipment operator, Technician, Foreman, Other

17. What percentage of the time do you spend on each of the following areas to get the job done?
Marketing, Pit operation design, Pit operations, Public relations, Government relations, Employee relations

18. Is the company planning to invest in more land, equipment or manpower in the next 5 years? Yes No

19. Related to aggregate production what are your biggest challenges?_____

_____

_____

_____

20. How many pits are you operating on private land? _____, public land _____

21. Of your private land pits, how many have Conservation & Reclamation (C&R) approval? __

22. Is the C&R plan a beneficial tool for designing and operating a pit? Yes No

23. Do you hire a consultant to develop the C&R plan? Yes No

24. How much capital does your company invest to obtain the approvals to bring a pit into operation? _____

25. How many times have your application for approvals been rejected? _____

26. How long does it take to get an approval to get a pit operational? _____

27. Is the timing for obtaining approvals acceptable? Yes No

28. Is it easier to obtain approvals on public land versus private land? Yes No

29. What are the biggest challenges in meeting approval standards? Yes No

30. Alberta Environment is contemplating dropping the C&R plan and approval requirement for private land operations. Are you in favor? Yes No

31. What is your concept of sustainable development? _____

_____

_____

_____

_____

_____

32. Have you employed any sustainable development principles in your operations? Yes No

a) If yes, describe.

_____

_____

_____

_____

_____

b) If no, do you employ any environmental management systems in your operations? Yes No

c) If yes, describe._____

_____

_____

_____

33. Does your company hire professionals for site assessments, pit development design or reclamation solutions? Yes No

34. Will you be hiring any specialists in the near future? Yes No

35. Are any of your operations associated with water resources (ground or surface water)?

Yes No

36. Do you operate any differently if your pit encounters or is close to water resources?
Yes No
a) If yes, describe

_____
_____
_____
_____

37. Do you receive the Federal government's production questionnaire? Yes No
38. Is the questionnaire difficult to complete? Yes No
39. Do you feel the federal statistics are accurate, somewhat accurate, not accurate?
40. Has the level of competition over the last 5 years increased, decreased or remained unchanged.
41. Are aggregate operations over regulated? Yes No
42. What percentage of the other operators compiling with the regulations? Yes No
43. Does this effect your competitive level? Yes No
44. What is required to create a level playing field for operators?

_____
_____
_____
_____
_____

45. How can operators mitigate public opposition to extraction operations?

_____
_____
_____
_____
_____
_____
_____

46. Is the Alberta Sand and Gravel Association effectively representing your interests?
Yes No

a) If no, what changes are required?

_____
_____
_____
_____
_____
_____

47. How many years of aggregate reserves does your company have at the current consumption rates? _____
48. How much money is invested in aggregate exploration work annually? _____

49. Should government be protecting the access to potential aggregate resources? Yes
No

a) If yes, how?

_____

_____

_____

Additional input

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

Appendix C

APPENDIX C: Industry Survey

	A	B	C
1	**Business Type Question #1**	**Operating span (years) Q2.**	**Employee number Q4**
2	Producer/Processor 1	68	150
3	Producer/Processor 2	4	15
4	Producer 3	40	10
5	Consultant 4	7	1
6	Producer/Processor 5	38	7
7	Producer/Processor 6	34	50
8	Producer/Processor 7	60	100
9	Processor 8	38	30
10	Consultant 9	6	2
11	Producer/Processor 10	9	2
12	Producer/Processor (potential) 11	0	2
13	Consultant 12	50	200
14	Producer/processor 13	15	10
15	Consultant 14	3	5
16	Producer 15	26	3
17	Producer/Processor 16	25	40
18	Processor 17	36	0
19	Producer/processor 18	27	200
20	Producer 19	57	2
21	Totals or Averages	28.57894737	829

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	D	E
1	**Number of pits-private land Q20**	**Number of pits-public land Q20**
2	20	0
3	0	1
4	1	0
5	NA	NA
6	0	17
7	19	1
8	10	2
9	0	0
10	NA	NA
11	4	1
12	0	0
13	NA	NA
14	0	2
15	NA	NA
16	0	1
17	0	1
18	0	0
19	9	6
20	22	1
21	85	33

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	F	G
1	**Products Q6**	**Highest Demand Q10**
2	Asph., conc., road base	
3	Road crush, asp., seal coat.	road crush
4	15	road gravel
5	C&R plans	NA
6	Road construction	Base coarse
7	Base materials, road construction, specialty rocks, railroad ballast	GBC
8	Redi-mix concrete	washed aggregate
9	Abrasive, filter media, forestry grits traction products, sports field underlay, golf coarse sand.	Abrasives
10	NA	NA
11	Masonary sand, concrete blend sand	Crushed rock
12	Railway ballast, crushed aggregate.	crushed aggregate
13	Contracts	Contracts
14	landscape/building stone, lime	recycle aggregate
15	Approvals	Approvals
16	Pit run	Concrete spec aggregate
17	granular base; asphalt	20mm crush
18	concrete	limestone
19	20	road crush
20	Pit run	pit run
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	H	I	J
1	**Main Client Q11**	**Production rate** 2001(tonnes) Q12	**Haul rate (max.) (km) Q13**
2	Private cos.	6,000,000	80
3	Govt.	100,000	250
4	Private cos.	40,000	40
5	Private cos.	NA	NA
6	Private cos.	150,000	220
7	Govt.	2,000,000	135
8	Private cos.	5,000,000	80
9	Private cos.	100,000	35
10	Govt.	NA	NA
11	Private cos.	30,000	24
12	Private cos.	0	NA
13	Private cos.	NA	NA
14	Private cos.	700,000	750
15	Private cos.	NA	NA
16	Private cos.	2,707,669	80
17	Govt.	300,000	50
18	No response	130,000	5
19	Govt.	4,000,000	90
20	Govt.	250,000	30
21		21,507,669	133.5

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	K	L	M
1	**Haul distance** (average) (km) Q14	***Capital Investment** CDN$ Q15	**Increase investment next 5 years? Q18**
2	30	1	Yes
3	150	2	Yes
4	20	2	Yes
5	NA	NA	Yes
6	25	1	Yes
7	70	4	Yes
8	25	5	Yes
9	30	4	Yes
10	NA	NA	No response recorded
11	24	1	Yes
12	NA	1	Yes
13	NA	NA	No
14	8	5	Yes
15	NA	NA	Yes
16	7	2	No
17	30	2	Yes
18	1.5	NA	No response recorded
19	30	5	Yes
20	20	1	Yes
21	33.60714286		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	N	O	P
1	**C&R plans beneficial? Q22**	**Number of plan rejections Q25**	**Approval timing (years) Q26**
2	No	2	3
3	Yes	4	4
4	Yes	NA	NA
5	Yes	No reponse recorded	2 (Private - 6 weeks to 5 months; Public-
6	No	1	1
7	No	1	1 (3 months-1 year)
8	Yes	0	1
9	NA	NA	NA
10	Yes	0	NA
11	Yes	4	1 (6 months-1 year)
12	Yes	0	1 (over 1 year)
13	Yes	No reponse recorded	2 (90 days to 2 years)
14	Yes	0	0.33
15	Yes	0	0.5
16	Yes	No reponse recorded	No response recorded
17	Yes	0	1.5
18	Yes	1	2
19	Yes	2	0.5
20	Yes	1	2 (6 months - 2 years)
21		16	1.2

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	Q	R
1	**Approval timing acceptable? Q27**	**Approval process most efficient Q28**
2	No	No comment
3	No	NC
4	NA	NA
5	Yes	Private
6	Yes	Unknown
7	No	Private
8	No	Public
9	NA	NA
10	NA	NA
11	No	Private
12	Yes	NA
13	No	Private
14	Yes	No reponse recorded
15	No	Private
16	No response recorded	NA
17	No	No response
18	No	No response
19	No	Public
20	No	Private
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	S	T
1	**Applicantion challenges Q29**	**Agree to Code of Practice Q30**
2	Public opposition	No
3	Unknown rules	Yes
4	NA	NA
5	water quality issues; land use conflicts	No
6	Survey requirements; C&R plan requirements applied to small operations	Yes
7	Timing	Yes
8	Reclamation in areas of little topsoil	Yes
9	NA	No opinion
10	regulations in constant fluculation	No
11	Number of people involved	No
12	Number of people involved	No
13	Hours of operation	No
14	None	No opinion
15	Meeting public's expectations	No
16	NA	No opinion
17	endorsement by adjacent landowner	Yes
18	Finding the right approach	No
19	Red tape	No
20	public oppostion, other resource values	Yes
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	U	V
1	**Can sustainable development apply to aggregate resources Q31-32**	**Employ SD principles Q32**
2	Yes	Yes
3	Yes	No
4	Yes	Yes
5	Yes	Yes
6	Yes	No
7	Yes	Yes
8	Yes	Unsure
9	Yes	Yes
10	Yes	Yes
11	Yes	No
12	Yes	Yes
13	Yes	Yes
14	Yes	Yes
15	Yes	Yes
16	Unknown	No response recorded
17	Yes	Yes
18	No	Yes
19	Yes	Yes
20	Yes	Yes
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	W	X
1	**Operations associated with water resources Q35**	**If yes, different procedures? Q36**
2	Yes	pumping
3	Yes	buffers, siltation ponds
4	Yes	impored material, buffers
5	Yes	Yes
6	Yes	No
7	Yes	buffers, fuel handling
8	Yes	No
9	No	NA
10	No response recorded	No response recorded
11	Yes	Filtration system, lubrication control
12	NA	NA
13	Yes	Habitat enhancement opportunity
14	No	NA
15	Yes	Diiferent information
16	Yes	designed drainage system
17	Yes	only pit
18	Yes	buffer - 100m
19	Yes	Yes
20	Yes	buffers
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	Y	Z	AA
1	**Federal survey received Q37**	**Survey difficult? Q38**	**Accuracy of federal stats? Q39**
2	Yes	Yes	not accurate
3	No	NC	No opinion
4	Yes	NO	somewhat accurate
5	NA	NA	no response recorded
6	Yes	Yes	no response recorded
7	Yes	Yes	not accurate
8	No	NC	No opinion
9	No	No opinion	No opinion
10	No	NA	No opinion
11	Yes	Yes	not accurate
12	No	No opinion	No opinion
13	No response recorded	No response recorded	No response recorded
14	No	NA	No opinion
15	NA	NA	No opinion
16	No	NA	No opinion
17	No	NA	No opinion
18	No response recorded	No opinion	No opinion
19	No	No opinion	No opinion
20	Yes	No	not accurate
21			

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AB	AC
1	**Competition level Q40**	**Sector over regulated? Q41**
2	unchanged	No
3	Unchanged	No
4	Increased	Yes
5	unchanged	No
6	Increased	No
7	Increased	No
8	unchanged	Yes
9	Increased	No opinion
10	Increased	No
11	Increased	Yes
12	Increased	unknown
13	decreased	Yes
14	unchanged	No
15	unchanged	No
16	No response recorded	No
17	increased	No
18	No response recorded	No
19	Increased	No
20	increased	Yes
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AD	AE
1	**Percentage of operators compiling with regs. Q42**	**Effect on competitive level Q43**
2	40%	No
3	0%	No
4	95%	No
5	60%	NA
6	NC	NC
7	95%	Yes
8	75%	Yes
9	NC	NC
10	95%	No response recorded
11	95%	No response recorded
12	Unknown	Unknown
13	90%	No
14	95%	No
15	90%	NA
16	No opinion	NA
17	100%	No
18	80%	No response recorded
19	NC	NC
20	70%	Yes
21	77%	

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AF
1	**Needs for level playing field Q44**
2	Enforcement
3	Manditory reclamation, Fair allocation system
4	eliminate politics with approval process
5	Enforcement
6	Political favouraitism
7	Enforcement, coorporation between operators
8	Enforcement
9	No input
10	Enforcement
11	Incentives for small operators
12	education
13	Profit-risk ratio should be taken into consideration
14	Quality control
15	Consistant and enforced standarsds, process pushing small operator out
16	Provincial support access to resource
17	Access equality
18	No input
19	Enforcement
20	self regualtion
21	

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AG	AH
1	**ASGA representation improvements Q46**	**Resource reserves-years Q47**
2	More resources	50
3	NC	4
4	Low cost and productive	20
5	Identify sector shared objectives and pursue vigourously by active lobbying	NA
6	NC	20
7	NC	20
8	NC	25
9	No input	NA
10	No input	NA
11	NC	50
12	Unknown	NA
13	Hire dedicated staff	No
14	No input	25
15	Proper budget, employ qualified personel	NA
16	No opinion	50
17	No input	10
18	No input	15
19	No input	NA
20	ASGA become issuer of licences	100
21		32.41666667

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AI	AJ
1	**Annual Exploration investment-CDN$ Q48**	**Employment of Environment Systems Q32c**
2	50,000-100,000	EMS, ISO 9000 concrete
3	15,000-20,000	No
4	2000	Yes
5	20,000	NA
6	10,000	No
7	30,000	Yes
8	Sporatic varible amounts	Unknown
9	NA	Yes, air quality
10	NA	NA
11	0	No
12	10,000	NA
13	No response recorded	Yes
14	0	Yes
15	NA	Yes ISO 14000
16	Unknown	Yes
17	$25,000	No
18	0	Unsure
19	No response recorded	Yes
20	75,000-100,000	Yes
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AK	AL
1	**Challenges Q19**	**Use of Professionals Q33**
2	Capital costs, attracting employees and shareholders	Yes
3	Approval process	Yes
4	Competition with multinationals	Yes
5	Progressive reclamation	Yes
6	Competition, lack of sources	No
7	Attracting employees, meet specs. Access to resources	Yes
8	Reclamation	Yes
9	Raising costs, finding markets and meeting specifications	No
10	Find suitable aggregate to meet specs.	Yes
11	Variable approval processes, meeting specs., public opposition, restrictive hauling routes.	Yes
12	Approvals, government contacts difficult to determine	Yes
13	Government red tape and resource sector public image	Yes
14	Marketing and sales	Yes
15	NIMBY opposition	Yes
16	Coordinating pit activities	Yes
17	Availibility of resources	Yes
18	Find aggregates close to market that are not tied up.	No
19	Long process	Yes
20	Permits	Yes
21		

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AM	AN
1	**Cost to Obtain Approvals** ($) Q24	**Should Govt. Protect Resource Q49**
2	250,000	Yes-impartial intervener
3	20,000	Yes- access
4	15,000	Yes-inventory
5	10,000+	No
6	3,000	Yes
7	30,000	Yes
8	Unknown	Yes
9	No response recorded	Yes
10	Unknown	Yes
11	20,000	Yes
12	10,000+	Yes
13	NA	No
14	60,000	Yes
15	3,000-30,000	Yes
16	No response recorded	Yes
17	20,000	Yes
18	15,000	Yes
19	50,000-150,000	NA
20	5000-50,000	Yes
21	43,000	

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AO
1	**Methodology to Gain Public Accpetence Q45**
2	Improved operations, public awareness program.
3	No comment
4	Contribute to community, pay insurance reduction for broken window
5	Early public disclosure
6	No comment
7	Control noise, dust, hours. Trucking policy.
8	Operating responsibility, opportunity of public input on a continual basis.
9	No comment
10	Government eduacate public on resource importance, municipal authorities of need for inventory and planning
11	Strict rules, speed control of truck traffic, taxation on road use, provincial wide taxation.
12	No public oppostion in area of interest
13	mediator involvement from the beginning of extraction development proposal. Public hearingd with provincial ruling of opposition.
14	Run forums to educate public
15	Communicate, educate, be transparent, unbias mediator
16	No comment
17	Public pits
18	Compensate community members for impact of operations
19	NA
20	recognitionof necessity of developing resource
21	

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million

APPENDIX C: Industry Survey

	AP
1	**Additional input**
2	pro-active process
3	
4	Operators should be on top of community compliants
5	Industry must take initiative to develop regulatory frame work
6	Monitor of royalties is required, red tape of operating increasing
7	EUB ruling allowed pipeline development over gravel extraction
8	Have government protect access to the resouces
9	
10	Under estimated economic benefit for country
11	Sector not treated with same priority as other sectors
12	Aboriginal referral of resource applications in BC; BC geological survey release resource information through accepted procedures
13	Political involvement in approvals detrimental to sector
14	
15	Require a full land assessmemt in development process, third party auditing procedure required if sctor to self regulate
16	Government's involvement in Ft. McMurray aggregate sector has improved in the last few years, Susan Lake Public Pit
17	Improve public image: public benefits conveyed, reclamation successes, improved resource management
18	Better control over licencing, approval process has improved, outline resource and pit limits.
19	
20	regulation by another body other than the municipal level, central licencing agency.
21	

*Capital investment categories: 1-under $100,000; 2-$100,000-$500,000; 3-$500,000-$1 million; 4-$1 million-$2 million; 5-$2 million-$5 million; 6-over $5 million